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MODEL No. PM3234

10MHz DUAL-BEAM STORAGE OSCILLOSCOPE

ROCKFORD INSTRUMENT LAB
1718 Broadway
Rockford, IL 61108

10 MHz Dual-beam storage oscilloscope PM3234

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Scientific & Industrial Equipment Division

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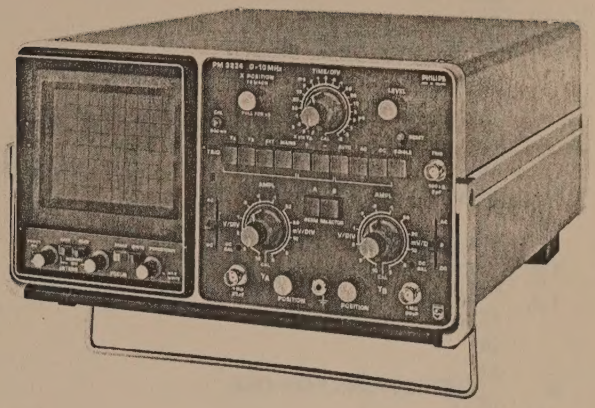

Instruction manual
Anleitung
Notice d'emploi et d'entretien

10 MHz DUAL - BEAM STORAGE OSCILLOSCOPE
10 MHz ZWEISTRAHL - SPEICHEROSZILLOGRAF
10 MHz OSCILLOSCOPE DOUBLE TRACE A MEMOIRE

PM3234

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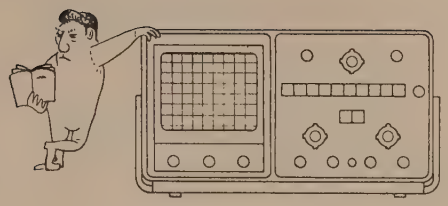
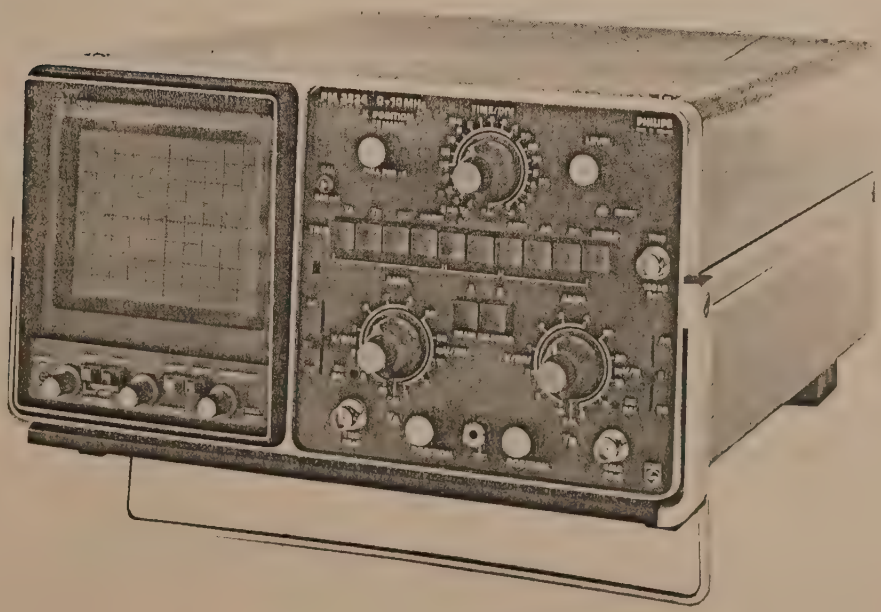
1. GENERAL INFORMATION



1.1. Introduction

The 10 MHz Dual-beam storage Oscilloscope PM 3234 has been designed for general laboratory, service and educational applications.
Both vertical amplifiers are equipped with a drift-reduction circuit, a delay line and a fully protected field-effect transistor input. All circuits are entirely transistorized and the transistors have been mounted on supports to enable quick servicing.
The instrument can be supplied from either a.c. mains or external d.c. sources.
Waveform are stored in the PM 3234 by using a conventional electron gun assembly to form a charge pattern on the surface of a storage layer. This pattern can be maintained for a considerable period of time, even when the apparatus has been switched off.
The length of time that a stored image remains displayed depends upon the degree of display brightness used, and can be longer than two hours. It is possible to store several single shot waveforms in order to display them simultaneously.
An erase facility enables stored information to be cancelled immediately at will.

The PM 3234 also incorporates a feature which enables display persistence to be varied over a wide range. This enables a stable display of repetitive slow-speed signals without flicker effects. The variable persistence feature also enables fast h.f. signals to be displayed. In this case, several cycles are used to develop the image on the memory layer so that a clear display can be obtained. Such displays may be obtained using signals with repetition rates as low as one cycle per minute. Single shot signals which are normally too fast for display by a conventional oscilloscope may be written by means of a 'max. write' facility. Because of the high degree of sensitivity involved in this mode of operation, display quality is slightly degraded.



1.2. Characteristics

Properties expressed in numerical values with stated tolerance are guaranteed for nominal mains voltages. Numerical values without tolerances are typical values representing the characteristics of an average instrument.

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.1. C.R.T.		
Type	PHILIPS L14-130GH	Split-beam tube, mesh type, post-accelerator, metal-backed phosphor, half-tone storage
Measuring area	8x10 divisions	1 div. equalling 0,9 cm
Screen type	P31 (GH) phosphor	
Total acceleration voltage	8,5 kV	
Overlap of the two systems	100 %	Both in horizontal and vertical direction
Graticule	Internal	
Engravings	8x10 divisions with sub-divisions along the central axes. Dots indicate 10 % and 90 % of measuring lattice.	
Persistence	In MEMORY OFF mode medium short	Natural persistence of P31 phosphor
	In WRITE mode from $< 0,3$ s to $\geqslant 1,5$ min	Continuously variable
Storage time	In READ mode $\geqslant 3$ min In SAVE mode $\geqslant 15$ min	
Writing speed	$\geqslant 100$ div/ms $\geqslant 1$ div/μs	In MEMORY OFF mode In MAX. WRITE mode
Erasure	approx. 600 ms	Push-button operated
1.2.2. VERTICAL AMPLIFIERS		
1.2.2.1. Response		
Frequency range	d.c. ... 10 MHz 2 Hz ... 10 MHz	–3 dB bandwidth d.c. coupled –3 dB bandwidth a.c. coupled
Rise time	35 ns	
Overshoot	2 % at maximum	Test pulse of 10 ns rise time for 6 div deflection at 1 MHz
1.2.2.2. Deflection coefficients	2 mV/div. ... 10 V/div.	Twelve calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : $\geqslant 2,5$
1.2.2.3. Error limit	± 3 % ± 5 %	In range +5 °C ... +40 °C In range –10 °C ... +55 °C
1.2.2.4. Maximum permissible input voltage	± 400 V	d.c. + a.c. peak

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.2.5. Instability of the spot position		
Long-term drift = short-term drift	0,25 div/hour	Typical value
1.2.2.6. Vertical positioning	16 div	
1.2.2.7. Dynamic range	24 div	Peak-to-peak amplitude for sine-wave signals; up to 3 MHz negligible distortion
1.2.2.8. Input impedance	1 MOhm/20 pF	
1.2.2.9. Input RC time	0,1 s	Coupling switch to A.C.
1.2.2.10. Visible signal display	$\geqslant$ 40 nsec	Difference between the channels 0,1 division
1.2.3. X-Y MODE	X via Y_A	x5 magnifier inoperative
Horizontal frequency range	d.c. ... 1 MHz 2 HZ ... 1 MHz	
Phase shift	5^o 1^o	At 100 kHz At 10 kHz
Additional error for Y_A channel	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4. TIME BASE		
1.2.4.1. Time coefficients	0,5 s/div ... 0,2 μs/div	Twenty calibrated positions in 1-2-5 sequence Uncalibrated continuous control 1 : $\geqslant$ 2,5
1.2.4.2. Coefficient error	± 5 %	In range −10 °C ... +55 °C
1.2.4.3. Expansion		
Magnification	5x	Switched, calibrated
Additional error	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4.4. Time-base output signal		
Output voltage	300 mV	With 50 Ohm termination
Emf (open output voltage)	6 $V_{p\text{-}p}$ (−2 V to +4 V)	The output terminal may be short-circuited without affecting the time coefficients
Internal resistance	1 kOhm	
1.2.4.5. Positioning range	The beginning and the end of the time-base line can be made visible	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.5. TRIGGERING		
1.2.5.1. Source	Internal: channel Y_A, channel Y_B or mains freq. External	
1.2.5.2. Trigger sensitivity	Internal $\leqslant$ 1 div at 10 MHz External $\leqslant$ 1 $V_{p\text{-}p}$ at 10 MHz	For sine-wave signals
1.2.5.3. Input impedance	100 kOhm//5 pF	
1.2.5.4. Maximum permissible input voltage	± 400 V	d.c. + a.c. peak
1.2.5.5. Trigger mode	Auto A.C. D.C. Single	20 Hz ... $\geqslant$ 10 MHz 10 Hz ... $\geqslant$ 10 MHz 0 Hz ... $\geqslant$ 10 MHz
1.2.5.6. Level range	Corresponding to trace height 24 div 24 V	In the automatic mode In the A.C., D.C. and single mode External
1.2.5.7. Triggering frequency range	10 Hz ... 10 MHz d.c. ... 10 MHz 20 Hz ... 10 MHz	A.C. coupling D.C. coupling A.C. coupling in the automatic mode
1.2.5.8. Triggering slope	+ or –	
1.2.6. CALIBRATION GENERATOR		
Type	Square-wave generator	
Output voltage	600 $mV_{p\text{-}p}$	
Accuracy	± 1 %	In range +5 °C ... +40 °C
Frequency	approx. 2 kHz	
1.2.7. OPERATING CONDITIONS		
1.2.7.1. Supply	a.c. or d.c.	
Nominal voltage range (on mains voltage adaptor)	a.c. 90 V ... 140 V 180 V ... 265 V d.c. 22 V ... 30 V	
Nominal frequency range	46 Hz ... 400 Hz	
1.2.7.2. Ambient temperature		
Rated range of use	+5 °C ... +40 °C	
Limit range of operation	–10 °C ... +55 °C	
Storage and transport conditions	–40 °C ... +70 °C	
1.2.7.3. Operating position	Any	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.8. WARM-UP TIME	5 minutes	At constant ambient conditions (not including recovery time; see also section 2.1.6.)
1.2.9. POWER CONSUMPTION	61 VA at 220 V a.c. 30 W at 24 V d.c.	 1,25 A current drain
1.2.10. MAINS INTERFERENCE	The instrument meets the VDE Storgrad K requirement	
1.2.11. MECHANICAL DATA		
Design	Portable	
Dimensions	Depth 503 mm Width 326 mm Height 185 mm	Incl. front cover Incl. handle Incl. feet
Weight	Approx. 11,5 kg	
1.2.12. COOLING	Natural convection	
1.2.13. COMPONENT REPLACEMENTS	Normal production types, transistors plugged in	

1.3. Accessories

1.3.1. STANDARD ACCESSORIES

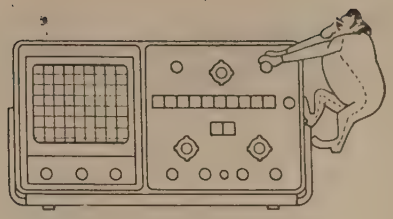
1 Front cover with storage space for two passive probes and two BNC-4 mm adapters
2 BNC-4 mm adapters PM 9051
1 Manual

1.3.2. OPTIONAL ACCESSORIES

Passive probe sets (10 : 1)	: PM 9326 and PM 9327
Passive probe sets (10 : 1)	: PM 9336 and PM 9336L
Passive probe sets (1 : 1)	: PM 9335 and PM 9335L
2 kV passive probe set (100 : 1)	: PM 9358
Probe power supply	: PM 9346
Active micro-miniature probe (10:1)	: PM 9352
Active FET probe (2 : 1)	: PM 9353
Current probe	: PM 9355
Set of miniature probe clips	: PM 9333
Multi-purpose oscilloscope camera	: PM 9380
Adapter (oscilloscope to camera)	: PM 9379
19" rackmount set	: PM 9359

See also chapter 3.5. "Information concerning accessories".

2. DIRECTIONS FOR USE



2.1. Installation

2.1.1. REMOVING AND FITTING THE FRONT COVER

Removing : — Turn the knob in the centre of the cover a quarter of a turn anti-clockwise
— Take the cover off

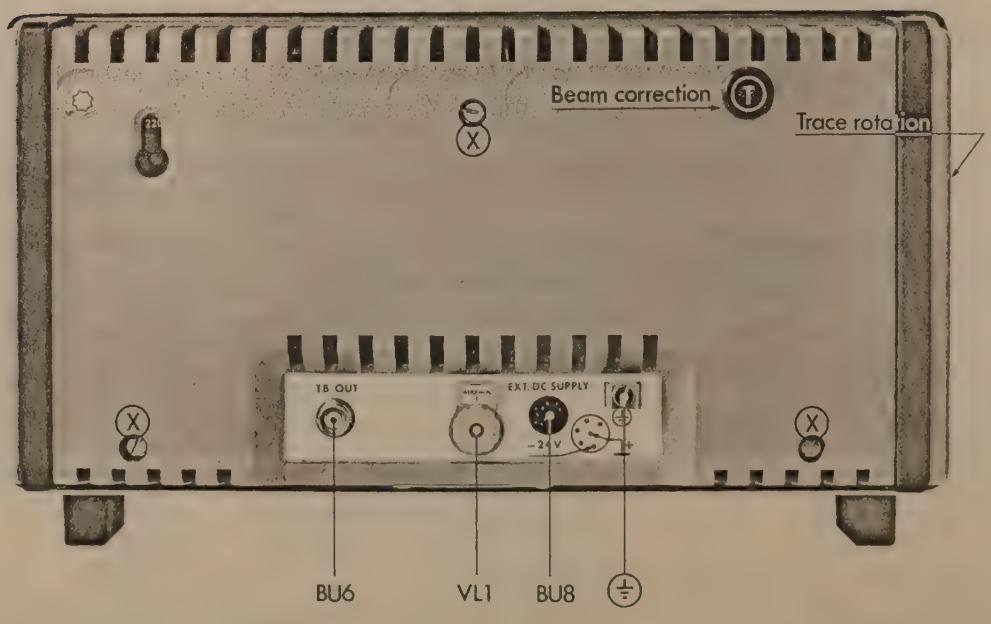
Fitting : — Align the key of the locking knob with the slot in the text plate of the instrument
— Fit the cover over the front of the oscilloscope
— Press the knob and turn it a quarter of a turn clockwise

WARNING

This instrument generates high voltages and should not be operated with the covers removed. The mains plug or external voltage source should be removed before attempting any maintenance work, and any relevant high voltage points dischanged.

2.1.2. ADJUSTING TO THE LOCAL MAINS SUPPLY AND FUSES

Before switching-on, the instrument must be adjusted to the local mains voltage by means of the voltage adapter at the rear of the instrument.
It is possible to adjust the instrument to 110 V, 127 V, 220 V and 240 V by means of a screwdriver.
The selected voltage is visible through the opening at the rear.
The instrument can optionaly (Spec. transformer) be adapted for 100 V, 120 V, 200 V and 220 V.
The fuse holder on the rear panel normally carries a 400 mA delayed action mains fuse but if the instrument is to be connected to a mains voltage of less then 200 V, a 800 mA fuse must be fitted.
Check that the fuse is of the specified type and current rating before connecting the oscilloscope to the mains.
The use of repaired fuses and the short-circuiting of fuse holders is prohibited.



2.1.3. SUPPLY FROM AN EXTERNAL D.C. SOURCE

The instrument may be supplied from an external d.c. source of 22 V to 30 V, 1,25 A. This voltage is to be applied to EXT. D.C. SUPPLY socket BU8. THE POSITIVE TERMINAL OF THE VOLTAGE SOURCE MUST BE CONNECTED TO EARTH, AS INDICATED IN THE DIAGRAM ON THE REAR TEXT PLATE, SINCE THE POSITIVE SIDE OF THE POWER SUPPLY IS CONNECTED TO CHASSIS.
The instrument is protected against reverse connection. In the case of external d.c. supply, the instrument is protected by fuse VL802 (Fig. 2.2) which is located on the power supply board and accessible after removing the rear cover. VL802 is a delayed action 1,6 A fuse.

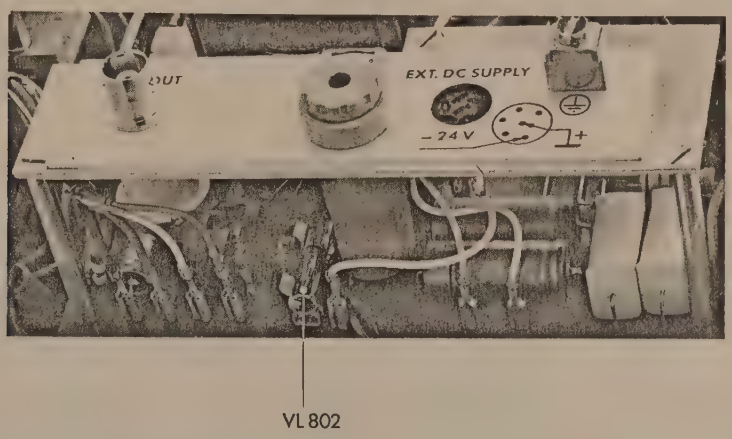


Fig. 2.2. Rear view showing fuse VL802

2.1.4. EARTHING

In the interest of safety, the oscilloscope must be connected to earth via the rear earthing terminal (identified by the symbol ⏚) or via the mains lead, provided that the supply socket is equipped with an earth connection. Care must be taken that the earth line to the oscilloscope is not interrupted due to the use of an extension lead or device which is not fitted with an earth conductor.

2.1.5. SWITCHING ON

The instrument is switched on in case of mains supply, by means of the mains switch incorporated in the INTENS control. The mains cable is located in a compartment at the bottom of the instrument.

In case of external d.c. supply, the mains switch is inoperative and the instrument is on as soon as the external source is connected. In both cases, the ON position is indicated by the white pilot lamp.

The instrument may be used in any position, but care should be taken that a free air circulation is not impeded. For temperature conditions refer to section 1.2.7.2.

2.1.6. FROM THE COLD INTO THE WARMTH

In section 1.2. Characteristics you can read that the instrument works within the specifications after a warm-up period of five minutes and at an ambient temperature between +5 °C and +40 °C.
There is, however, one exception. If you leave, for instance, your oscilloscope in your car overnight when it is freezing and then bring it into a room with a temperature of 25 °C the following morning, condensation will occur on the components.

The high-ohmic resistors in your oscilloscope then cease to be high-ohmic because of leakage currents caused by the condensation, and the oscilloscope does not work properly. In this situation, you must allow approximately 2 hours for your oscilloscope to acclimatize until all condensation has evaporated.

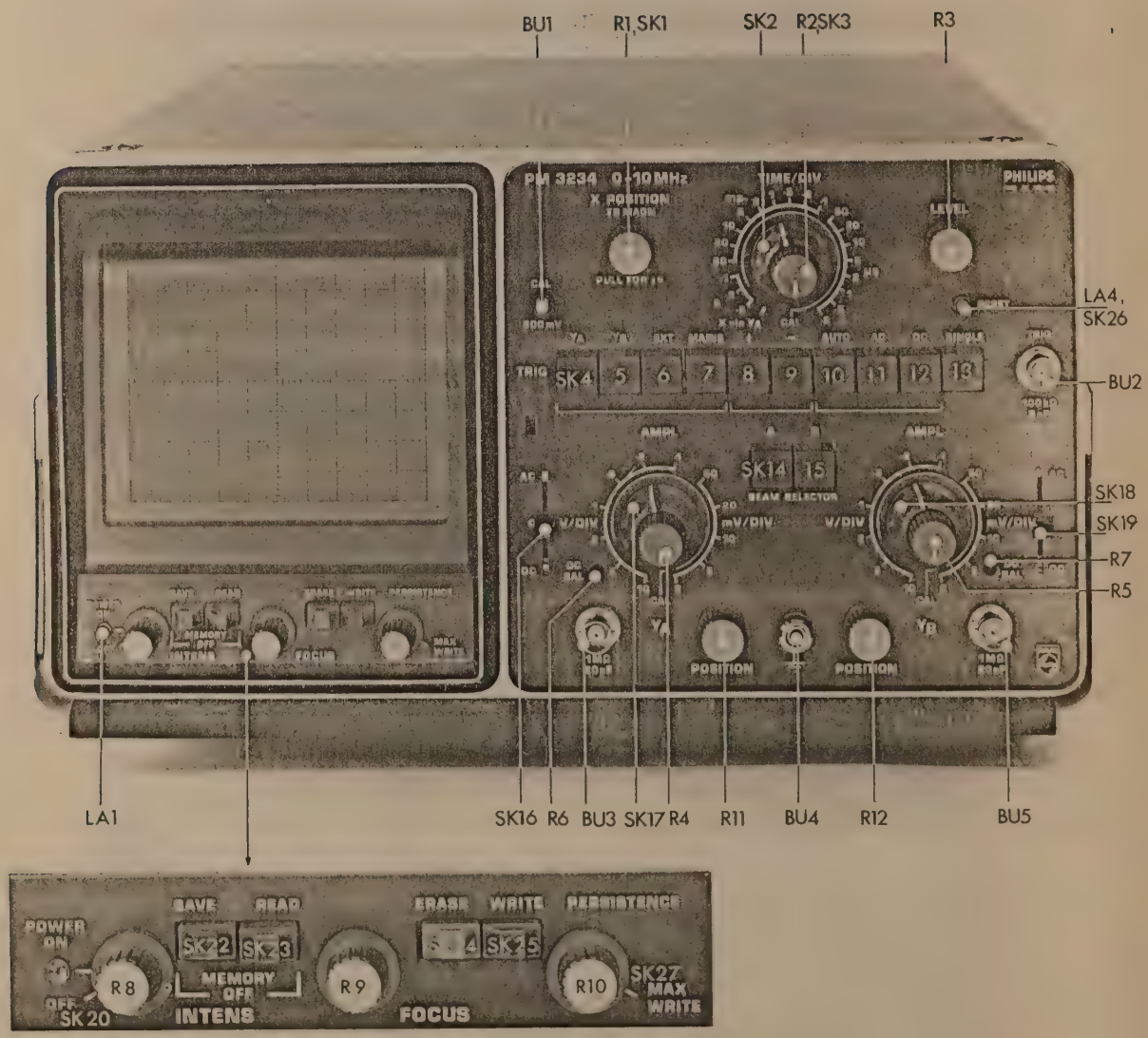


Fig. 2.3. Front view showing controls and sockets

2.2. Operating instructions

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with chapter 2.1. Installation, and that the precautions outlined have been observed.

2.2.1. CONTROLS AND SOCKETS (Fig. 2.3.)

X POSITION (R1)	Continuously variable control giving horizontal positioning of the display.
MAGN' (SK1)	Incorporates a switch for calibrated 5x magnification of the time base.
TIME/div (SK2)	Time-coefficient control of the time-base; 21-way switch with a position for external X deflection (X via Y_A).
CAL. - TIME/div (R2/SK3)	Continuously variable control of the time coefficients. In the CAL. position the time-coefficient is calibrated.
LEVEL (R3)	Continuously variable control to select the level at which the time-base generator starts.
CAL. (BU1)	Outlet for square-wave voltage of 600 mV_{p-p} for calibration purposes.
TRIGGERING (SK4...13)	Controls for trigger source, slope and mode; 10-way push-button switch.
Y_A (SK4)	Internal triggering signal derived from channel Y_A.
Y_B (SK5)	Internal triggering signal derived from channel Y_B.
EXT. (SK6)	Triggering signal derived from a voltage applied to the TRIGG. input socket.
MAINS (SK7)	Triggering signal derived from an internal voltage with mains frequency. This trigger source is inoperative when the instrument is supplied with an external d.c. voltage.
+ (SK8)	Provides for triggering on the positive slope of the signal.
– (SK9)	Provides for triggering on the negative slope of the signal.
AUTO (SK10)	Provides for a free-running time-base in the absence of triggering signals. and automatic signal-derived limitation on the LEVEL control range.
AC (SK11)	Triggering with coupling capacitor in triggering-signal path.
DC (SK12)	Direct coupling for triggering on a slowly varying voltage or for full-bandwidth working.
SINGLE (SK13)	If this push-button is depressed, the instrument operated in the SINGLE sweep mode.
RESET (SK26)	If switch SINGLE is in the depressed position, the time-base runs only after pressing the RESET button upon receipt of a trigger pulse.
TRIGG. (BU2)	Input BNC socket for external triggering signals.
BEAM SELECTOR A (SK14)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_A input.
BEAM SELECTOR B (SK15)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_B input. If both switch A (SK14) and switch B (SK15) are depressed, vertical deflection is achieved by both the signal connected to the channel Y_A input and the signal connected to the channel Y_B input.
AC-0-DC (SK16 & 19)	Signal coupling, three position switch. AC : via coupling capacitor O : interruption of connection between input socket and input circuit, the latter being earthed. DC : Direct coupling.

AMPL. (SK17 & 18)	Control of the vertical deflection coefficients, 12-way switch.
CAL. - AMPL. (R4 & 5)	Continuously variable control of the vertical deflection coefficients. In the CAL. position, the deflection coefficient is calibrated.
DC BAL. (R6 & 7)	Continuously variable control of the direct-voltage balance of the vertical amplifier.
INTENS (SK20 & R8)	Continuously variable control of the trace brilliance Incorporated mains switch.
SAVE (SK22)	To store the recorded waveform for a longer viewing time (protected against accidental erasure).
READ (SK23)	To observe the recorded waveform (protected against accidental erasure).
MEMORY OFF (i.e. SAVE and READ pushed simultaneously)	Allows operation of the instrument as an ordinary oscilloscope.
FOCUS (R9)	Continuously variable control of the electron-beam focusing.
ERASE (SK24)	Erases the stored display, except in the SAVE and READ mode when ERASE is disabled.
WRITE (SK25)	To record the waveform; in this mode PERSISTENCE (R10) is operative.
PERSISTENCE (R10 & SK27)	Permits variable retention of the recorded waveform. Incorporates MAX. WRITE switch.
MAX. WRITE	To increase the writing speed by a factor of approx. 10.
1 MOhm - 20 pF (BU3 & 5)	Input BNC socket for the vertical deflection signals.
POSITION (R11 & 12)	Continuously variable control giving vertical positioning of the display.
⏚ (BU4)	Earth socket.

At the rear of the instrument (Fig. 2.1.):

TB OUT (BU6)	Sawtooth output BNC socket.
TRACE ROTATION (R813)	Adjusts trace to align with the horizontal graticule lines.
EXT. DC SUPPLY (BU8)	Input socket for d.c. supply.
SCREW T	To equalize brightness of both traces.

2.2.2. PRELIMINARY SETTINGS

We recommend to allow a warm-up time of five minutes before you start your measurements. This warm-up time does not include a recovery time when the instrument comes in from the cold (see also section 2.1.6.).

— In case of mains operation:
  Check that the mains voltage adapter indicates the local mains voltage. If necessary, set the adapter to the relevant voltage in accordance with 2.1.2.
  Switch on the instrument.
— In case of external d.c. supply:
  Check that the external source is properly connected, with the positive terminal to earth.

CAUTION
EXTENDED HIGH INTENSITY MAY DAMAGE THE CRT

In the "Variable persistence" mode of operation, the CRT itself warns for too high an intensity by "blooming". When "blooming" occurs, intensity should be reduced by turning knob INTENS, R8, slightly counter-clockwise.

In the "MEMORY-OFF" and "X-Y" mode of operation, such indication does not occurs, so special care should then be taken.

2.2.2.1. Use as an ordinary oscilloscope

— The memory function of the CRT can be switched off by simultaneously pushing button SAVE, SK22, and READ, SK23. (MEMORY OFF position).
— Set FOCUS control R9 and INTENS. control R8 to their mid-positions.
— Depress BEAM SELECTOR buttons A SK14 and B SK15. Bear in mind that their will be no display if no BEAM SELECTOR button is depressed.
— Select trigger source, slope and mode. If no TRIGG. button has been depressed, the oscilloscope triggers on the Y_A signal, on the positive slope and in the AUTO mode without level range limitation.
— Display the two traces by means of Y POSITION controls R11 and R12.

The oscilloscope is then ready for use. For correction of the d.c. balance, refer to section 3.2.4.2.

2.2.2.2. Use as a storage oscilloscope

Starting from the MEMORY OFF position, when the INTENS control, R8, is adjusted for a convenient brightness of the trace and the FOCUS control, R9, is adjusted for optimum sharpness, the STORAGE mode of operation can be obtained by pushing button WRITE, SK25.

Persistence	Depending on the position of PERSISTENCE potentiometer, R10, a quickly vanishing trace will be written on a green background (R10 entirely counter-clockwise) or a slowly vanishing trace on a black background (R10 touching its first clockwise stop). The persistence can be set to suppress any flickering when displaying a low-frequency signal. For a signal with a low repetition-rate and a short rise-time, the persistence can be set so as to fill-up the trace in order to obtain a clear and steady display.
Save	If a particular trace must be retained, it can be saved by pushing button SAVE, SK22. The trace is then just visible.
Read	The intensity of the stored trace increases after pushing the READ button, SK23, but the brightness goes at the expense of storing time.
Erase	When the trace is no longer needed it can be erased by pushing button ERASE, SK24. It may happen that the trace has not entirely vanished, especially those parts which were written with a substantial brightness. This can be overcome by a prolonged actuation of the "ERASE" button.
Max. write	The writing speed can be increased by a factor of approx. 10 by putting PERSISTENCE control, R10, in its MAX. WRITE position i.e. touching its second clockwise stop, so that switch SK27 is switched over. The MAX. WRITE mode of operation is required for short sweep times or for signals with a short rise-time.

2.2.3. INPUTS Y_A AND Y_B AND THEIR POSSIBILITIES

The PM 3234 has been provided with two identical vertical channels which can be used for either YT measurements in combination with the time-base generator, or XY measurements up to frequencies of 1 MHz, and with the possibility to store the displays in different modes.

2.2.3.1. YT Measurements

To display one signal, either of the two vertical channels can be selected by operating either BEAM SELECTOR A SK14 or BEAM SELECTOR B SK15. When both push-buttons A SK14 and B SK15 are depressed, two signals can be displayed simultaneously. The Y deflection coefficient can be individually set for each channel.

2.2.3.2. XY Measurements

If TIME/div switch SK2 is set to position X via Y_A, the time base generator is switched off.
The signal of the Y_A channel is displayed horizontally. The Y_A controls, except the POSITION potentiometer R11, then control the X deflection. Positioning of the trace in horizontal sense is still possible with X POSITION control R1. The x5 MAGNIFIER switch SK1, however, is inoperative.
In this mode, XY measurements can be up to a frequency of 100 kHz.

2.2.3.3. Influence of the AC-0-DC switch

Signals to be studied can be fed to Y_A input socket BU3 and/or Y_B input socket BU5. Depending on the composition of the signal, the AC-0-DC switch should be set to position AC or DC. In position DC, the input is coupled direct to the Y amplifier. Because the Y amplifier is d.c. coupled, the entire bandwidth of the instrument is available. This means that the complete input voltages are fed to the deflection plates, which implies that the d.c. components result in trace shifts on the screen.
This may cause difficulties when a.c. signals superimposed on high direct voltages have to be displayed.
In oder to make the a.c. signal visible in those cases, a greater attenuation will be necessary with the result that the a.c. signal will also be strongly attenuated.

In this case the AC-0-DC switch can be set to position AC. Then a blocking capacitor is connected between the input socket and the Y amplifier. As a result of this, d.c. voltages are blocked, but also the lower frequencies are suppressed or attenuated. When square-wave signals of low frequency are displayed, this will result in some pulse droop.
In the 0 position of the AC-0-DC switch it is possible to quickly determine the zero volt d.c. level.
In this position the connection between the amplifier input and the input socket is interrupted, the amplifier input being earthed. At the same time, the blocking capacitor is discharged to prevent damage of the circuit under test by a possible high charge.

2.2.4. TRIGGERING

2.2.4.1. General

In order to obtain a stationary trace, the horizontal deflection must always be started at a fixed point of the signal. The time-base generator is, therefore started by narrow trigger pulses formed in the trigger pulse shaper (Schmitt trigger), controlled by a signal originating from the vertical input signal or an external source.

2.2.4.2. Trigger coupling

AC — If the signal voltage contains a d.c. component triggering can cease when the level potentiometer cannot supply the correct d.c. level for the Schmitt trigger. In this case it is useful to apply a.c. coupling. A.C. Coupling is obtained by inserting a capacitor in the trigger path. This means that the signal can still be d.c. coupled to the Y channels.

DC — D.C. Coupling is useful when the mean value of the signal varies. This sort of signal often occurs in digital systems. With a.c. coupling the trigger point would not be fixed which would give rise to jitter or even loss of triggering.

2.2.4.3. Trigger level

In case of a complicated signal in which a number of non-identical voltage shapes occur periodically, the time axis should always be started with the same voltage shape so as to obtain a stationary trace.
This is possible when one of the details has a deviating amplitude. By means of the LEVEL knob, the trigger level can be set in such a way that only this larger voltage variation passes this level. The LEVEL control is also very useful when two signals must be accurately compared e.g. in phase measurements. By means of the LEVEL control the starting point of the traces can then be shifted exactly on to the control graticule line.

2.2.4.4. Automatic triggering

Automatic triggering, when the AUTO switch is depressed, is most often used on account of its simple operation.
In this mode it is possible to display a large variety of waveforms having different amplitude and shape, without it being necessary to operate any of the trigger controls.
If no triggering signal is present, a time-base line remains visible on the screen. This is useful for zero reference purposes. In this trigger mode the level can be adjusted over the peak-to-peak value of the a.c. components of the signal. If none of the switches AUTO, AC or DC is depressed, the oscilloscope works in the automatic mode, but with the entire level range available. This has the advantage that there is always a trace visible, even when no TRIGG. push-buttons are depressed.

2.2.4.5. External triggering

External triggering is applied for signals having a strongly varying amplitude, if a signal having a fixed amplitude and equal frequency is available. Even more important is external triggering in case of complex signals and pulse patterns. Then external triggering can be used to avoid double traces.
This obviates the necessity of readjusting the level setting at every variation of the input signal.

2.2.4.6. Triggering with the mains frequency

In this case the triggering signal is a sine-wave with the mains frequency. This trigger source is useful if the frequency of the signal under observation is coupled with the mains frequency.
It is, e.g., possible to recognize the hum component of a signal by triggering on that component.

2.2.4.7. Position SINGLE and use of the RESET push-button

When effects which occur only once have to be observed, it is often desirable to ensure that only one sweep is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sweep in question must be triggered by a trigger pulse. To this end the mode switch must be put into position SINGLE. When the RESET button has been pressed, the first following trigger pulse that appears will start the time-base generator. The trace is only written once. The time-base is then blocked until the RESET push-button is again operated.
The lamp in the RESET push-button, will light up as soon as this button is operated and will go out as soon as the sweep is initiated.

2.2.5. TIME-BASE MAGNIFIER

The magnifier is operated with a push-pull switch.
When this switch is in the x5 position, the time-base sweep speed is increased 5 times. In this position the sweep time is determined by dividing the indicated TIME/div value by 5.

2.2.6. THE DUAL-BEAM STORAGE TUBE

2.2.6.1. Storage principle

The PM 3234 oscilloscope contains a cathode-ray tube with a storage mesh with variable storage time. Therefore, the c.r.t. may be used as an ordinary one, but with a variable persistence of the displayed signal.

Information is stored by writing the signal of the main electron beam into a STORAGE LAYER of non-conductive material. As a result of the secundary emission of electrons from this layer, a positive charge pattern is formed. This charge pattern on the storage surface will remain there for a considerable length of time, also if the writing gun is switched off. The trace is displayed on the phosphor viewing screen by means of a second electron beam whose electrons can strike the phosphor via the positively charged parts on the storage layer.

Storage of information on non-conductive material is based on secundary emission. Fig. 2.4. shows the ratio between the number of electrons leaving the storage layer and the number of electrons arriving (secundary emission ratio) versus the surface potential. At a certain surface potential, V_a in Fig. 2.4. the number of electrons leaving the surface equals the number of electrons arriving. This point is called the first cross-over (secundary emission ration = 1).

If the surface of the storage layer is hit by electrons of higher energy (electrons with greater velocity), the surface will become more positive, since more electrons are leaving than arriving. If the surface is hit by electrons of lower energy (electrons with lower velocity) than at V_a, the surface potential becomes more negative, as fewer electrons are leaving than arriving.

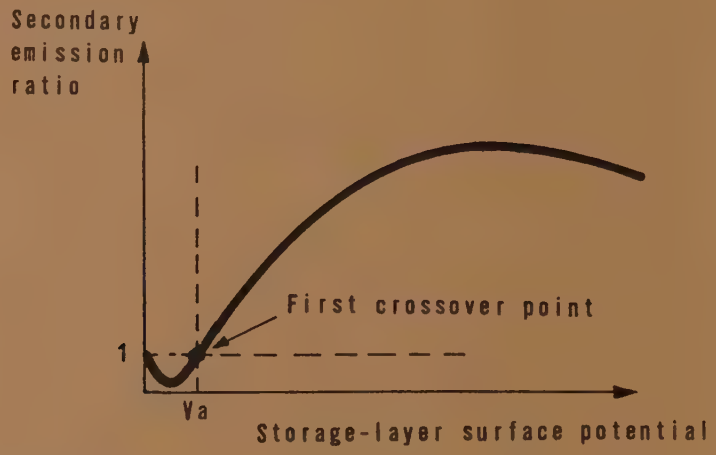


Fig. 2.4. Secondary emission ratio

2.2.6.2. Construction and operation of the storage c.r.t.

The dual-beam storage cathode-ray tube contains two systems: the WRITING system and the FLOOD system.

The dual-beam WRITING part comprises one gun in which two beams are generated that are deflected independently. This arrangement is also known as split-beam system. In this tube, both time-base lines are exactly in parallel since they originate from one point and are under the influence of one common horizontal signal amplifier. Because both traces are emitted by one gun, they show little distortion in relation to one another.

The FLOOD system consists of a pair of FLOOD GUNS operated in parallel. Both guns comprise a CATHODE c, a CONTROL GRID g1 and an ACCELERATOR GRID g2 (see Fig. 2.5.). Common to both flood guns are the FLOOD BEAM COLLIMATOR g7, the COLLECTOR MESH g8, the STORAGE MESH g9 which carries the storage layer, and the PHOSPHOR VIEWING SCREEN g10.

The flood guns are located at a point ahead of the horizontal deflection plates and the mesh. The cathode potential is approx. +30 V, this being 50 V negative in relation to the accelerator grids. Both flood gun cathodes emit a cloud of electrons. These clouds are combined by both control grids g1, accelerated by both accelerator grids g2 and shaped by the collimator g7 which consists of a coating on the inner surface of the c.r.t. bottle. The positive voltage on the collimator is such that the electron cloud emanating from the flood gun just fills the viewing area of the c.r.t.

The cloud is further accelerated in the direction of the storage mesh and the viewing screen by collector mesh g8. After passing through the collector mesh, the flood-gun electrons are controlled by the potentials on the storage mesh and storage layer surface.

A front view of the collector and storage meshes is shown in Fig. 2.6. The apertures in both meshes are approximately 40 x 40 μm. The cathode side of the storage mesh is coated with a non-conductive material on which the information is stored (see Fig. 2.7.). In other words, there exists a capacitive coupling between the storage mesh and the storage-layer surface. This capacitive coupling is essential for the proper working of the STORE and ERASE functions. The storage mesh is normally at a potential of approximately +2 V in relation to the flood-gun cathode potential, i.e. approximately +32 V with respect to earth.

The potential V_a at the storage-layer surface is controlled by WRITE and ERASE signals which are applied to the storage mesh, and varies between 2 V positive and 4 V negative in relation to the flood-gun cathode. When the storage-layer surface is at a potential of +2 V in relation to the cathode (see Fig. 2.8.), the majority of flood-gun electrons pass through the holes in the mesh and reach the phosphor screen. The remaining electrons are repelled by the storage-layer surface and collected by the collector mesh. When the potential of the storage-layer surface is negative in relation to the cathode (see Fig. 2.9.), the number of electrons passing through the storage mesh is drastically reduced or, when the cut-off level is reached, no electrons pass at all.

The post-accelerator voltage of approximately 7 kV is connected to the phosphor viewing screen. Electrons that are allowed to pass through the storage mesh are accelerated by this potential and strike the phosphor with such a velocity that a brilliant spot is obtained.

The storage-mesh may be compared to the grid of a triode. Just as the triode grid potential controls the anode current, the storage mesh controls the current of flood-gun electrons to the screen and, thus, the trace brilliance.

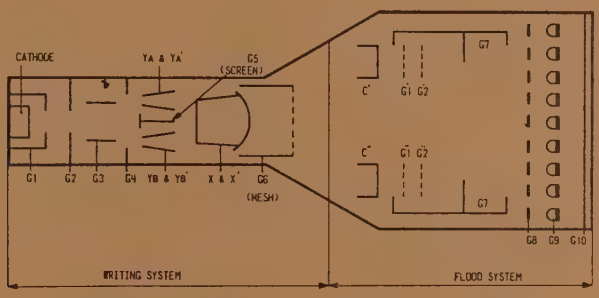


Fig. 2.5. Simplified CRT construction

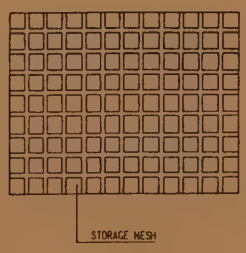


Fig. 2.6. Mesh construction used for collector and storage grids

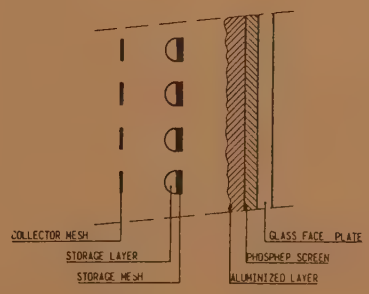


Fig. 2.7. Detail of storage system construction

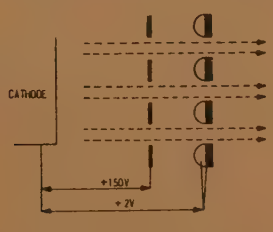


Fig. 2.8. Storage system at full brightness

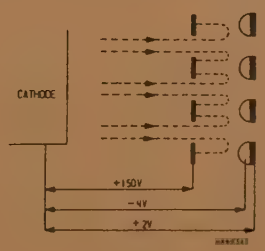


Fig. 2.9. Storage system at cut-off

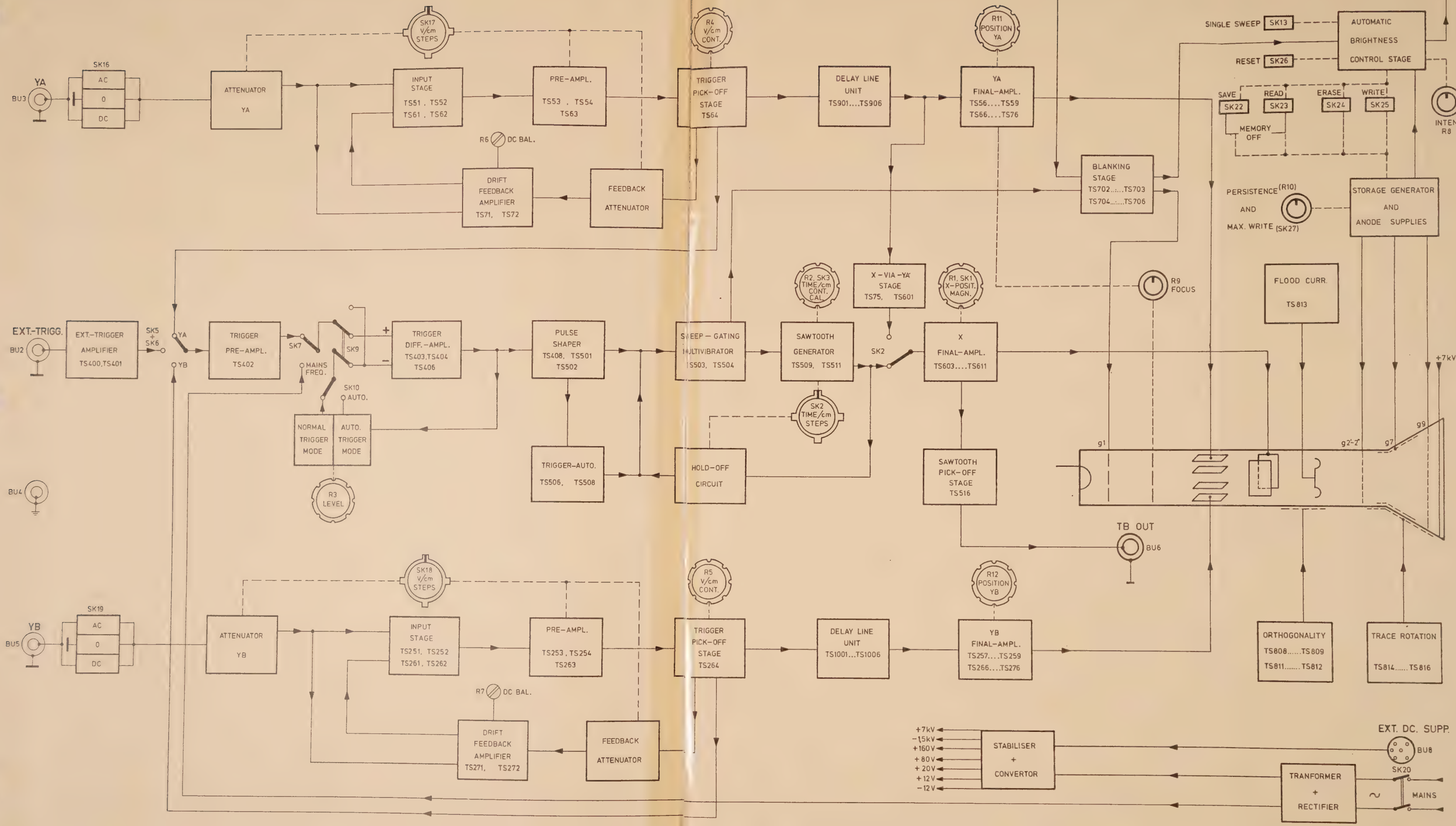


Fig. 2.10. Block diagram
Abb. 2.10. Blockschaltbild der Driftkompensation
Fig. 2.10. Schéma synoptique

2.3. Description of the block diagram

2.3.1. Y AXIS

The oscilloscope PM 3234 has two identical, d.c. coupled vertical amplifiers allowing simultaneous display of two signals. Each amplifier comprises an input step-attenuator, a source follower with protection circuitry, a pre-amplifier and a drift reduction circuit, a trigger pick-off stage, a delay line circuit and a final amplifier. Trigger pick-off stage and final amplifier (for both channels, Y_A and Y_B) have been coupled by means of the delay line circuit, which is a part of the circuitry of the delay line unit.
The protection circuitry prevents damage to the input field-effect transistors by too high sensitivity of the amplifier.

The trigger pick-off stage supplies a triggering signal to the trigger pre-amplifier in case of internal triggering, and also couples the signal to be measured to the Y final amplifier. In the Y_A channel the signal can also be coupled to the X final amplifier if the instrument is used as an XY oscilloscope. From the Y final amplifier, the signal is fed to the Y deflection plates of the c.r.t.

The delay line has been applied to enable the display of the leading edge of fast phenomena on the screen.

2.3.2. TRIGGERING

A triggering signal can be obtained from either vertical amplifier, from an external source or internally from the mains. The latter signal is not available when the instrument is supplied with an external d.c. voltage. The triggering signal is fed to a trigger pulse shaper which supplies well-defined trigger pulses to start the time-base generator. The trigger unit also comprises a single sweep circuit which causes the time-base generator to deliver one sawtooth pulse, after the RESET knob has been pressed and upon receipt of the trigger pulse. This circuit only works when switch SINGLE is depressed.

2.3.3. TIME BASE

The time-base generator is of the constant-current integrator type and supplies two output voltages.
A sawtooth voltage which is fed to the X final amplifier and an output socket at the rear of the oscilloscope and a gate pulse which controls the unblanking of the c.r.t. during the sweep.

2.3.4. X AXIS

The X final amplifier receives its input signal from either the time-base generator or from an external source via the Y_A channel. From the X amplifier the signal is fed to the horizontal deflection plates of the c.r.t. of the oscilloscope.

2.3.5. C.R.T. CIRCUITRY

The c.r.t. circuitry comprises circuits for trace blanking and unblanking, an automatic brightness control unit, circuits appertaining to the storage functions of the c.r.t. and networks for the correction of the c.r.t. characteristi

The a(utomatic) b(rightness) c(ontrol) unit ensures a virtually constant trace brilliance or a blanked trace in various display modes.

In the continuous-display mode, the trace is blanked and unblanked by a signal from the time-base generator. In the single-sweep mode, the trace is blanked via the a.b.c. unit.

The storage circuits provide the voltage levels and waveforms which are necessary for the storage operation of the c.r.t.

The correction networks comprise preset potentiometers for trace rotation, astigmatism, distortion and orthogonality correction.

The high voltages for the c.r.t. are generated by a converter which also delivers the other supply voltages.

2.4. Brief checking procedure

General: Brief checking procedure is carried out in the MEMORY OFF mode.
For all storage functions refer to chapter 3.2. (checking and adjusting).

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display.
> Extended high intensity may damage the C.R.T.

2.4.1. STARTING POSITIONS OF THE CONTROLS

- Depress buttons SAVE SK22 and READ SK23 simultaneously.
- Push-buttons Y_A SK4, + SK8 and BEAM SELECTOR A SK14 & B SK15 depressed.
- TIME/div switch SK2 to .1 ms.
- AMPL switches SK17 & SK18 to .1 V/div.
- MAGN switch SK1 to x1.
- POSITION potentiometers R1, R11 and R12 to their mid-positions.
- Adjust INTENS potentiometer R8 for minimum display brightness.
- TIME/div and AMPL potentiometers R2, R4 and R5 to CAL.

Unless otherwise stated, the controls always occupy the same position as in the previous check.

2.4.2. C.R.T. POSITION

- Adjust FOCUS potentiometer R9 and INTENS potentiometer R8 for a well-defined display.
- Centre both time-base lines, using POSITION potentiometers R1, R11 and R12.
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines.
  Correction possible with potentiometer R813 (Fig. 3.16.).
- Check the brightness equality of the two beams.
  Correction possible with screw T at the rear of the instrument (Fig. 2.1.).

2.4.3. VERTICAL CHANNELS

The check for channel Y_A is described, the relevant controls for Y_B are mentioned in brackets.

- Release BEAM SELECTOR B SK15 (A SK14).
- AC-0-DC switches SK16 & SK19 to 0.
- AMPL switch SK17 (SK18) to 2 mV/div.
- Check that the time-base line remains within 0,2 div in the centre of the screen. Correction possible with DC BAL potentiometer R6 (R7).
- AC-0-DC switch SK16 (SK19) to DC.
- Check that the time-base line has not moved more than 0,4 div. Correction possible with potentiometer R126 (R326), Fig. 3.19.
- AMPL switch SK17 (SK18) to .1 V/div.
- Apply a square-wave voltage of 600 mV_{p-p} ±0,5 %, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the trace height is 6 div ±2 %.
  Correction possible with R111 (R311), Fig. 3.18.
- Increase the frequency of the input voltage to 10 MHz.
- Check that the trace height is at least 4.2 div.

2.4.4. X VIA Y_A

– Depress BEAM SELECTOR A SK14 and B SK15.
– Set TIME/div switch SK2 to X via Y_A.
– AC-0-DC switch SK19 to 0.
– Apply a square-wave voltage of 600 mV_{p-p} ±0,5 %, 2 kHz, to Y_A input socket BU3.
– Check that the trace width is 6 div ±3 %.
Correction possible with potentiometer R601 (Fig. 3.17.).

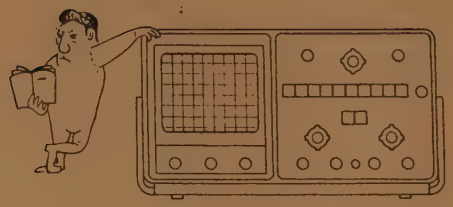
2.4.5. TIME-BASE

– Check the time-coefficient in position 20 μs of TIME/div switch SK2 by means of time markers.
Tolerance ±5 %. Correction possible with potentiometer R534 (Fig. 3.17.).
– Check the other time-coefficients; tolerance ±5 %.

2.4.6. TRIGGERING

– Apply a sine-wave voltage of 100 mV_{p-p}, 10 MHz, to Y_A input BU3.
– Check that it is possible to adjust LEVEL potentiometer R3 for a stationary display.

1. ALLGEMEINE INFORMATIONEN



1.1. Einleitung

Der 10-MHz-Zweistrahl-Speicher Oszillograf PM 3234 ist für allgemeine Laborarbeiten, den Service und für Unterrichtszwecke vorgesehen.
Beide Y-Verstärker besitzen eine Verzögerungsleitung und eine driftarme und voll überlastungsgeschützte Eingangsschaltung mit Feldeffekttransistoren. Alle Schaltungen sind voll transistorisiert. Die Transistoren stecken in Fassungen, damit sie nötigenfalls schnell ersetzt werden können.
Der Oszillograf kann mit Netzwechselspannung oder einer externen Gleichspannung betrieben werden.
Signalformen werden unter Anwendung einer konventionellen Elektronen Kanone, die auf der Oberfläche der Speicherschicht ein Ladungsbild formt, gespeichert.
Dieses Bild lässt sich über einen beträchtlichen Zeitraum festhalten, selbst wenn das Gerät ausgeschaltet wurde. Die Länge der Speicherzeit ist von der angewandten Darstellungshelligkeit abhängig und kann länger als zwei Stunden betragen.
Eine Löscheinrichtung ermöglicht es eine gespeicherte Information nach Belieben sofort zu annullieren.
Der PM 3234 enthält auch eine Vorrichtung womit die Nachlichtdauer der Darstellung über einen grossen Bereich variert werden kann. Dadurch wird stabile Darstellung von wiederholten Signalen niedriger Geschwindigkeit ohne Flimmern ermöglicht. Die variable Nachleuchtdauer ermöglicht auch die Darstellung schneller HF Signale. In einem solchen Fall wird die Darstellung auf der Speicherschicht in meheren Zyklen entwickelt um so eine deutliche Darstellung zu erhalten. Solche Signale erhält man durch Verwendung von Signalen von so niedriger Folgefrequenz wie ein Zyklus je Minute. Einmalige Impulse die normalerweise für Darstellung durch einen gewöhnlichen Oszillograf zu schnell sind lassen sich mit Hilfe der Betriebsart "MAX. WRITE" schreiben. Wegen der hohen Empfindlichkeit die diese Betriebsart zur Folge hat ist die Darstellungsqualität etwas geringer.

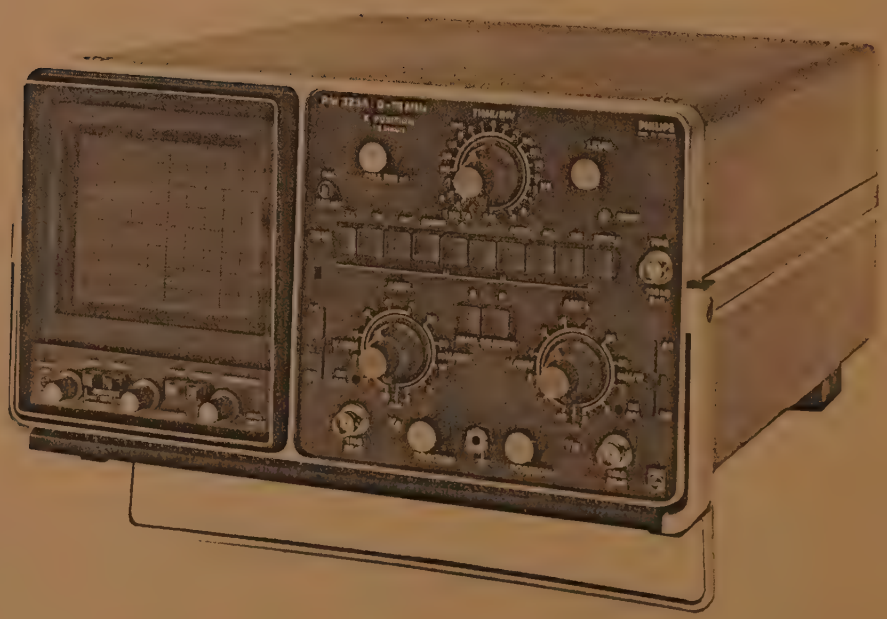


Abb. 1.1. Zweistrahl-Speicheroszillograf PM 3234

1.2. Technische Daten

Zahlenwerte mit Toleranzangabe werden bei den nominalen Netzspannungen garantiert. Zahlenwerte ohne Toleranzangabe sind Durchschnittswerte und dienen nur zur Information.

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.1. Elektronenstrahlröhre		
Type	PHILIPS L14-130GH	Spaltstrahlröhre (split-beam) mit Netz, Nachbeschleunigungselektrode und metallhinterlegtem Leuchtschirm, Halbtonspeicher.
Ausnutzbare Schirmfläche	8x 10 Div.	1 Div. beträgt 0,9 cm
Schirmtyp	Leuchtschirm P31 (GH)	
Gesamte Beschleunigungsspannung	8,5 kV	
Überlappung der beiden Systeme	100 %	Sowohl in horizontaler als auch in vertikaler Richtung
Raster	Intern	
Gravierung	8x 10 Div. mit Unterteilungen an den mittleren Achsen. Punkte bei 10 % und 90 % des Messrasters.	
Nachleuchtdauer	Bei Betriebsart MEMORY OFF medium short	Eigennachleuchtdauer von P31 Phosphor
	Bei Betriebsart WRITE von $< 0{,}3$ s bis $\geqslant 1{,}5$ min	Kontinuierlich variabel
Speicherzeit	Bei Betriebsart READ $\geqslant 3$ min Bei Betriebsart SAVE $\geqslant 15$ min	
Schreibgeschwindigkeit	$\geqslant 100$ Div./ms $\geqslant$ 1 Div./μs	Bei Betriebsart MEMORY OFF Bei Betriebsart MAX. WRITE
Löschen	In etwa 600 ms	Drucktaste betätigt.
1.2.2. Y-VERSTÄRKER		
1.2.2.1. Kennlinie		
Frequenzgang	d.c. ... 10 MHz 2 Hz ... 10 MHz	–3 dB, Gleichspannungskopplung –3 dB, Wechselspannungskopplung
Anstiegszeit	35 ns	
Überschwingen	max. 2 %	Gemessen mit einem Testimpuls mit einer Anstiegszeit von 10 ns bei einer Ablenkung von 6 Div. und einer Frequenz von 1 MHz
1.2.2.2. Ablenkkoeffizienten	2 mV/Div. ... 10 V/Div.	Zwölf kalibrierte Stellungen, Folge 1-2-5. Dazwischen stufenlos 1 : $\geqslant 2{,}5$ einstellbar.
1.2.2.3. Fehlergrenze	± 3 % ± 5 %	Im Bereich +5 °C ... +40 °C Im Bereich –10 °C ... +55 °C

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.2.4. Maximal zulässige Eingangsspannung	±400 V	Gleichspannung + Spitzenwert einer Wechselspannung
1.2.2.5. Instabilität des Leuchtflecks		
Langzeitdrift = Kurzzeitdrift	0,25 Div.	Typischer Wert
1.2.2.6. Vertikale Strahlverschiebung	16 Div.	
1.2.2.7. Dynamischer Bereich	24 Div.	Spitze-Spitze-Wert der Amplitude von Sinusspannungen; bis 3 MHz vernachlässigbare Verzerrungen
1.2.2.8. Eingangsimpedanz	1 MΩ//20 pF	
1.2.2.9. Eingangszeitkonstante	0,1 s	Kopplungsschalter auf AC
1.2.2.10. Sichtbare Signalverzögerung	⩾ 40 ns	Unterschied zwischen den Kanälen: 0,1 Div.
1.2.3. X-Y-BETRIEB	X über Y_A	5fache Dehnung ausser Betrieb
Horizontal	d.c. ... 1 MHz	
Frequenzbereich	2 Hz ... 1 MHz	
Phasenverschiebung	5°	Bei 100 kHz
	1°	Bei 10 kHz
Zusätzlicher Fehler für	± 2 %	Von +5 °C ... +40 °C
Y_A-Kanal	± 2 %	Von −10 °C ... +55 °C
1.2.4. ZEITABLENKUNG		
1.2.4.1. Ablenkkoeffizient	0,5 s/Div. ... 0,2 µs/Div.	20 geeichte Stufen, Folge 1-2-5. Dazwischen stufenlos einstellbar 1 : ⩾ 2,5.
1.2.4.2. Fehler des Zeitmassstabes	±5 %	Von −10 °C ... +55 °C
1.2.4.3. Dehnung		
Faktor	5x	Geschaltet, kalibriert
Zusätzlicher Fehler	±2 %	Von +5 °C ... +40 °C
	±3 %	Von −10 °C ... +55 °C
1.2.4.4. Ausgangsspannung des Zeitablenkgenerators		
Ausgangsspannung	300 mV	Mit 50-Ω-Abschluss
EMF (Leerlaufspannung)	6 V_{ss} (−2 V bis +4 V)	Ein Kurzschluss dieser Buchse hat keine Rückwirkungen auf die Ablenkkoeffizienten
Innenwiderstand	1 kOhm	
1.2.4.5. Verschiebebereich	Der Anfang und das Ende der Zeitablenklinie können sichtbar gemacht werden.	

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.5. TRIGGERUNG		
1.2.5.1. Triggerquelle	Intern: Kanal Y_A, Kanal Y_B oder Netzfrequenz Extern	
1.2.5.2. Triggerempfindlichkeit	Intern $\leqslant$ 1 Div. bei 10 MHz Extern $\leqslant$ 1 V_{ss} bei 10 MHz	Für Sinusspannungen
1.2.5.3. Eingangsimpedanz	100 kΩ//5 pF	
1.2.5.4. Maximal zulässige Eingangsspannung	±400 V	Gleichspannung + Spitzenwert einer Wechselspannung
1.2.5.5. Triggerauslösung	Auto Wechselspannung Gleichspannung Einzel	20 Hz ... $\geqslant$ 10 MHz 10 Hz ... $\geqslant$ 10 MHz 0 Hz ... $\geqslant$ 10 MHz
1.2.5.6. Pegelbereich	Entsprechend der Strahlhöhe 24 Div. 24 V	Bei automatischer Triggerung Bei Wechselspannung, Gleichspannung und Einzel Triggerung Extern
1.2.5.7. Triggerfrequenzbereich	10 Hz ... 10 MHz d.c. ... 10 MHz 20 Hz ... 10 MHz	Wechselspannungskopplung Gleichspannungskopplung Wechselspannungskopplung bei automatischer Triggerung
1.2.5.8. Triggerflanke	+ oder –	
1.2.6. KALIBRIERGENERATOR		
Typ	Rechteckgenerator	
Ausgangsspannung	600 mV_{ss}	
Fehlergrenze	±1 %	Von +5 °C ... +40 °C
Frequenz	ca. 2 kHz	
1.2.7. BETRIEBSBEDINGUNGEN		
1.2.7.1. Stromversorgung	Gleich- oder Wechselstrom	
Nominaler Spannungsbereich (sichtbar auf dem Netzspannungsumschalter)	Wechselspannungen 90 V ... 140 V 180 V ... 265 V Gleichspannung 22 V ... 30 V	
Nominaler Frequenzbereich	46 bis 400 Hz	
1.2.7.2. Umgebungstemperaturen		
Die technische Daten werden eingehalten von	+5 °C ... +40 °C	
Zugelassener Betriebstemperaturbereich	–10 °C ... +55 °C	
Lagerung und Transport	–40 °C ... +70 °C	

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.8. ANWÄRMZEIT	5 min.	Bei konstanten Umgebungsbedingungen (ohne Akklimationszeits; siehe auch Abschnitt 2.1.6.).
1.2.9. LEISTUNGSAUFNAHME	61 VA bei 220 V ~ 30 W bei 24 V =	Stromaufnahme 1,25 A
1.2.10. NETZ-STÖRGRAD	Das Gerät erfüllt die Anforderungen nach VDE Störgrad K	
1.2.11. MECHANISCHE DATEN		
Ausführung	Transportabel	
Abmessungen	Tiefe 503 mm Breite 326 mm Höhe 185 mm	Einschliesslich Frontdeckel Einschliesslich Handgriffe Einschliesslich Füsse
Gewicht	ca. 11,5 kg	
1.2.12. KÜHLUNG	Natürliche Luftzirkulation	
1.2.13. ERSATZ VON BAUELEMENTEN	Normale Serientypen, Transistoren steckbar	

1.3. Zubehör

1.3.1. STANDARDZUBEHÖR

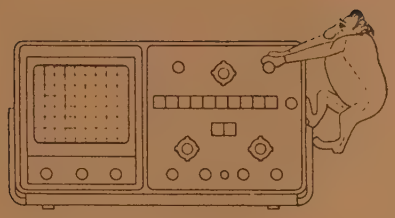
1 Frontdeckel mit Aufbewahrungsraum für zwei Spannungsteiler-Messköpfe und zwei Adapter BNC – 4 mm
2 Adapter BNC – 4 mm PM 9051
1 Anleitung

1.3.2. WAHLZUBEHÖR

Spannungsteiler-Messköpfe (10 : 1)	: PM 9326 oder PM 9327
Spannungsteiler-Messköpfe (10 : 1)	: PM 9336 oder PM 9336L
Messkopf (1 : 1)	: PM 9335 oder PM 9335L
2 kV Spannungsteiler-Messkopf (10 : 1)	: PM 9358
Messkopfspeisung	: PM 9346
Aktiver Mikro-Miniaturmesskopf (10 : 1)	: PM 9352
Aktiver FET-Messkopf (2 : 1)	: PM 9353
Strom-Messkopf	: PM 9355
Satz Miniaturmesskopfpinzetten	: PM 9333
Mehrzweck-Registrierkamera	: PM 9380
Adapter (Oszillograf/Kamera)	: PM 9379
19" Gestelleinbau-Satz	: PM 9359

Siehe auch Abschn. 3.5. "Information concerning accessories".

2. GEBRAUCHSANLEITUNG



2.1. Inbetriebnahme

2.1.1. ABNEHMEN UND AUFSETZEN DES DECKELS

Abnehmen : — Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen.
— Den Deckel abnehmen.

Aufsetzen : — Den Verriegelungsstift so ausrichten, dass er in den Schlitz in der Textplatte des Instruments passt.
— Den Deckel an der Vorderseite des Oszillografen befestigen.
— Den Knopf hineindrücken und eine viertel Umdrehung nach rechts drehen.

WARNUNG

In diesem Gerät werden hohe Spannungen erzeugt. Deshalb sollte es niemals in geöffnetem Zustand eingeschaltet werden. Vor Wartungsarbeiten ist der Netzstecker zu ziehen oder die externe Spannungsquelle abzuschalten und ist dafür zu sorgen, dass alle Hochspannung führende Teile entladen sind.

2.1.2. NETZSPANNUNGSEINSTELLUNG UND SICHERUNGEN

Vor dem Einschalten ist das Gerät mit dem Spannungsumschalter an der Rückseite an die örtliche Netzspannung anzupassen.
Das Gerät kann mit einem Schraubenzieher auf 110 V, 127 V, 220 V und 240 V eingestellt werden.
Die gewählte Spannung ist durch eine Öffnung an der Rückseite des Geräts sichtbar.
Auf Wunsch (Spez. Transformator) kann das Gerät auch für 100 V, 120 V, 200 V und 220 V geliefert werden.
Im Sicherungshalter an der Rückwand befindet sich normalerweise eine Sicherung von 400 mA, träge. Wird das Gerät an eine Netzspannung von weniger als 200 V angeschlossen, dann muss eine 800 mA Sicherung eingebaut werden. Vor Anschluss des Oszillografen an das Netz ist die Sicherung auf Typ und richtigen Wert zu kontrollieren. Es ist verboten reparierte Sicherungen zu verwenden oder die Sicherungshalter kurz zu schliessen.

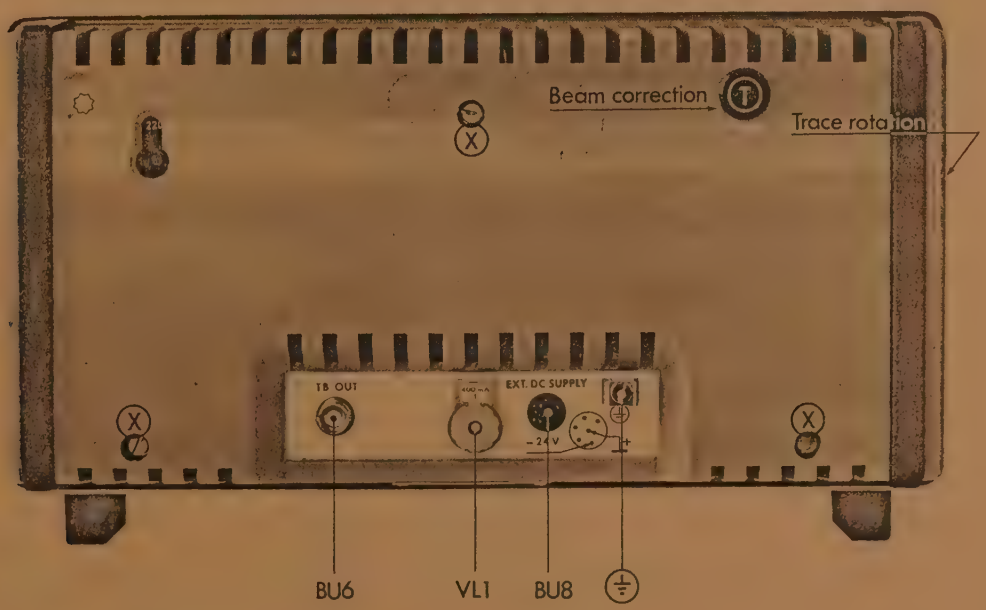


Abb. 2.1. Rückansicht mit Buchsen

2.1.3. ANSCHLUSS AN EINE EXTERNE GLEICHSPANNUNGSQUELLE

Das Gerät kann an eine externe Gleichspannung von 22 bis 30 V angeschlossen werden; die Stromaufnahme beträgt 1,25 A. Diese Spannung ist an Buchse BU8 EXT. D.C. SUPPLY anzuschliessen. DER PLUSPOL DER SPANNUNG IST MIT ERDE ZU VERBINDEN WIE ES IN DEM SCHALTBILD AN DER HINTEREN TEXTPLATTE ZU SEHEN IST, DA DER PLUSPOL DER STROMVERSORGUNG MIT DEM CHASSIS VERBUNDEN IST..
Bei einer falschen Polung der Spannungsquelle wird der Oszillograf nicht beschädigt. Beim Betrieb an einer externen Gleichspannung wird das Gerät von Sicherung VL802 (Abb. 2.2.) geschützt, die sich auf der Stromversorgungsleiterplatte befindet und nach Abnahme der Rückwand zugänglich ist. VL802 hat einen Wert von 1,6 A, träge.

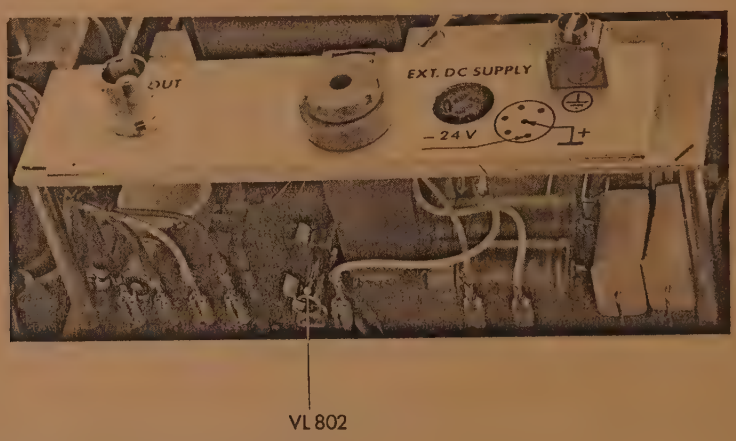


Abb. 2.2. Rückansicht mit Sicherung VL802

2.1.4. ERDUNG

Aus Sicherheitsgründen muss der Oszillograf über den Erdanschluss an der Rückseite (gekennzeichnet mit ⏚) oder über das Netzkabel, wenn das Gerät an eine Schukosteckdose angeschlossen wird, geerdet werden. Es ist auch darauf zu achten, dass die Erdverbindung des Oszillografen nicht durch ein Verlängerungskabel oder irgendeine andere Vorrichtung unterbrochen wird, die keinen Erdleiter besitzt.

2.1.5. EINSCHALTEN

Bei Netzbetrieb wird das Gerät mit dem Schalter eingeschaltet, der mit Bedienungselement INTENS gekoppelt ist. Das Netzkabel befindet sich in einem Fach unter dem Gerät. Beim Anschluss an eine externe Gleichspannung ist der Netzschalter ausser Betrieb. Das Gerät ist eingeschaltet, sobald die externe Gleichspannung angeschlossen ist. In beiden Fällen wird der Betriebszustand von der weissen Signallampe angezeigt.

Das Gerät darf in jeder Betriebslage verwendet werden, aber es ist darauf zu achten, dass die freie Luftzirkulation nicht behindert wird. Für die zulässigen Umgebungstemperaturen siehe Abschnitt 1.2.7.2.

2.1.6. INBETRIEBNAHME EINES UNTERKÜHLTEN GERÄTES

In Abschnitt 1.2. "Technische Daten" steht, dass das Gerät nach einer Anwärmzeit von 5 Minuten und in einem Temperaturbereich von +5 °C bis +40 °C die garantierten Daten einhält.
Es gibt hierbei aber eine Ausnahme. Wenn man zum Beispiel den Oszillografen nachts bei Temperaturen unter 0° im Auto lässt und dann am folgenden Morgen in einen Raum mit einer Temperatur von 25 °C bringt, tritt an den einzelnen Bauelementen Kondensation auf.
Die hochomigen Widerstände des Oszillografen verlieren durch die Leckströme herbeigerufen durch die Kondensation ihre Eigenschaften, wodurch der Oszillograf nicht mehr einwandfrei arbeitet. In diesem Fall ist etwa 2 Stunden zu warten, bis der Oszillograf akklimatisiert und alle Kondensationsflüssigkeit verdampft ist.

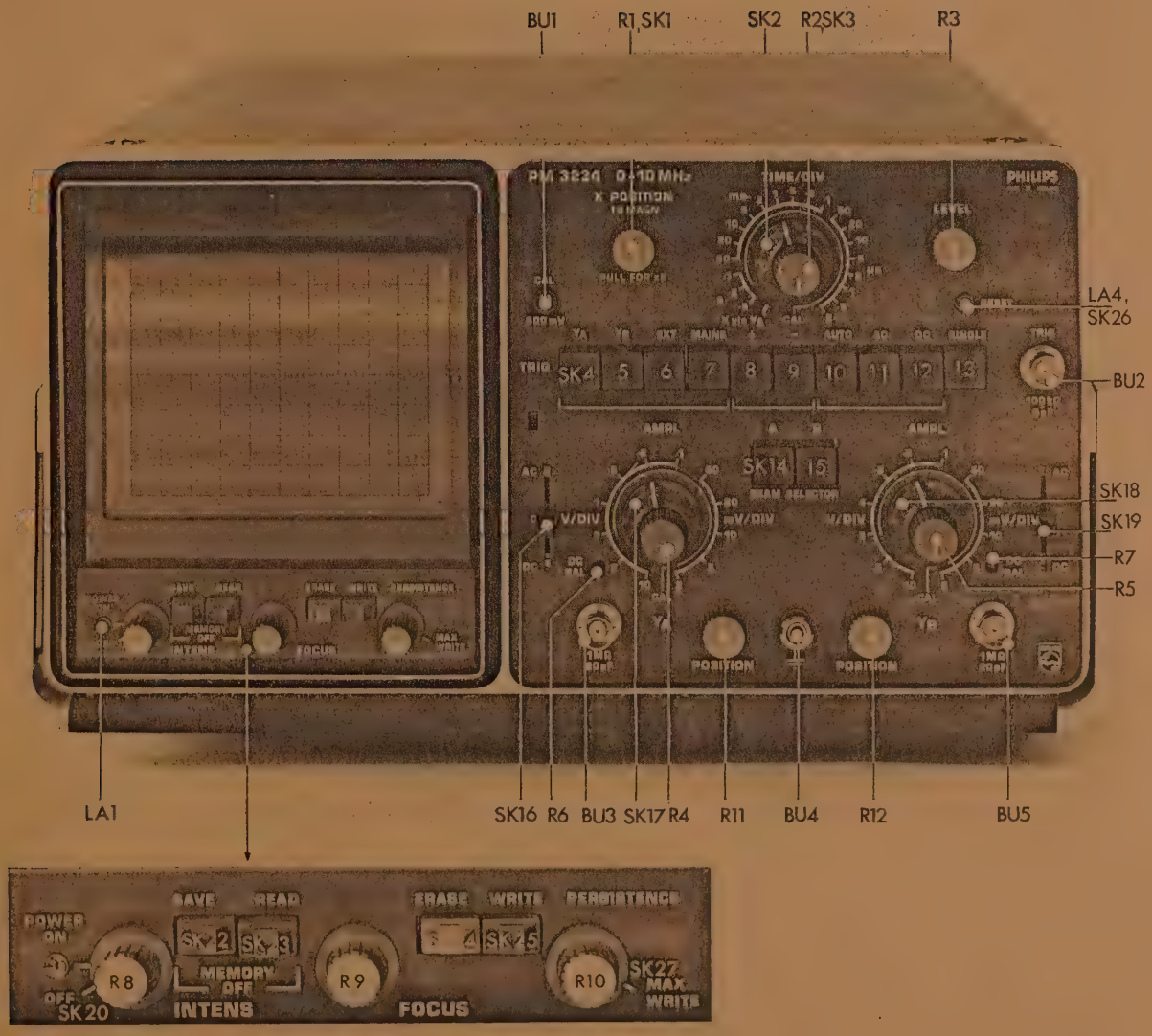


Abb. 2.3. Vorderansicht mit Bedienungsorganen und Buchsen

2.2. Bedienungsanleitungen

Vor dem Einschalten ist zu kontrollieren, ob der Oszillograf Abschnitt 2.1. "Inbetriebnahme" entsprechend angeschlossen ist und die dort beschriebenen Vorsorgemassnahmen beachtet wurden.

2.2.1. BEDIENUNGSORGANE UND BUCHSEN (Abb. 2.3.)

X POSITION (R1)	Stufenlos veränderliche Einstellung der horizontalen Lage des Elektronenstrahls. Mit Schalter für kalibrierte fünffache Dehnung der Zeitablenkung.
TIME/Div (SK2)	Einstellung des Zeitmassstabes; 21 stufiger Schalter mit einer Stellung für externe X-Ablenkung (X über Y_A).
CAL.-TIME/Div (R2/SK3)	Stufenlos veränderliche Einstellung der Zeitmassstäbe. In Stellung CAL ist der Zeitmassstab kalibriert.
LEVEL (R3)	Stufenlos veränderliche Einstellung des Pegels, bei dem der Zeitablenkgenerator startet.
CAL. (BU1)	Buchse mit Rechteckspannung von 600 mV_{ss} für Kalibrierzwecke.
TRIGGERUNG (SK4 ... 13)	10fache-Drucktaste für die Einstellung von Triggerquelle-Flanke und Art.
Y_A (SK4)	Triggersignal intern von Kanel Y_A abgenommen.
Y_B (SK5)	Triggersignal intern von Kanal Y_B abgenommen.
EXT. (SK6)	Triggersignal von der Triggereingangsbuchse abgenommen.
MAINS (SK7)	Triggersignal von einer internen Spannung mit Netzfrequenz abgenommen. Diese Triggerquelle ist bei Betrieb mit einer externen Gleichspannung nicht vorhanden.
+ (SK8)	Triggerung auf der positivgerichteten Flanke des Signals.
– (SK9)	Triggerung auf der negativgerichteten Flanke des Signals.
AUTO (SK10)	Freilaufende Zeitablenkung beim Fehlen von Triggersignalen und automatische vom zugeführten Signal abgeleitete Begrenzung des Pegeleinstellbereiches.
AC (SK11)	Triggersignal wird über Trennkondensator zugeführt.
DC (SK12)	Direkte Kopplung des Triggersignals bei einer sich langsam ändernden Spannung, oder wenn die volle Bandbreite erforderlich ist.
SINGLE (SK13)	Wenn diese Taste gedrückt ist, wird das Gerät in Betriebsart SINGLE betrieben.
RESET (SK26)	Wenn Schalter Single eingedrückt ist, läuft die Zeitablenkung nur einmal nach Drücken der Taste RESET bei Ankunft eines Triggerimpulses.
TRIGG. (BU2)	BNC Buchse für externe Triggersignale.
BEAM SELECTOR A (SK14)	Wenn diese Taste gedrückt ist, wird das Signal von Kanal Y_A vertikal dargestellt.
BEAM SELECTOR B (SK15)	Wenn diese Taste gedrückt ist, wird das Signal von Kanal Y_B vertikal dargestellt. Wenn Schalter A (SK14) und Schalter B (SK15) gedrückt sind, werden sowohl das Signal von Kanal Y_A als auch das von Kanal Y_B vertikal dargestellt.

AC-0-DC (SK16 & 19)	Dreistellungenschalter für die Signalenkopplung. AC : über einen Trennkondensator 0 : Eingangsbuchse ist nicht mit der Schaltung verbunden, die Schaltung ist geerdet DC : Gleichspannungskopplung
AMPL. (SK17 & 18)	Einstellung der vertikalen Ablenkkoeffizienten, 12stufiger Schalter.
CAL. – AMPL. (R4 & 5)	Stufenlos veränderliche Einstellung der vertikalen Ablenkkoeffizienten. In Stellung CAL. sind die Ablenkkoeffizienten kalibriert.
DC BAL. (R6 & R7)	Stufenlos veränderliche Einstellung der Gleichspannungssymmetrie der Y-Verstärker.
INTENS (SK20 & R8)	Stufenlos veränderliche Einstellung der Strahlhelligkeit. Gekoppelt mit Netzschalter.
SAVE (SK22)	Speichert die registrierte Signalform für eine längere Darstellungszeit (geschützt gegen unbeabsichtichte Löschung).
READ (SK23)	Betrachtung der registrierten Signalform (geschützt gegen unbeabsichtichte Löschung).
MEMORY OFF (SAVE und READ gleichzeitig eindrücken)	Erlaubt Betrieb des Gerätes als normalen Oszillograf.
FOCUS (R9)	Stufenlose Einstellung der Fokussierung des Elektronenstrahls.
ERASE (SK24)	Löscht die gespeicherte Darstellung, ausser in Betriebsarten SAVE und READ, wenn ERASE ausgeschaltet ist.
WRITE (SK25)	Registrierung der Signalform; bei dieser Betriebsart ist PERSISTENCE (R10) wirksam.
PERSISTANCE (R10 & SK27)	Ermöglicht regelbares Festhalten der registrierten Signalform. Gekoppelt mit Schalter MAX. WRITE.
MAX. WRITE	Steigert die Schreibgeschwindigkeit ca. 10x.
1 MOhm – 20 pF (BU3 & 5)	BNC-Eingangsbuchsen für die Y-Verstärker.
POSITION (R11 & 12)	Stufenlose Einstellung der vertikalen Lage des Elektronenstrahls.
⏚ (BU4)	Erdungsbuchse

An der Rückseite des Gerätes (Abb. 2.1.):

TB OUT (BU6)	Sägezahnausgang, BNC-Buchse
TRACE ROTATION (R813)	Ausrichtung des Strahls mit den horizontalen Rasterlinien.
EXT. DC SUPPLY (BU9)	Eingangsbuchse für externe Gleichspannung.
Schraube T	Helligkeitsausgleich beider Strahlen.

2.2.2. GRUNDEINSTELLUNGEN

Wir empfehlen das Gerät 5 Minuten vor Beginn der Messungen einzuschalten. Diese Vorwärmzeit genügt allerdings nicht, wenn das Gerät aus einem kalten Raum kommt und erst akklimatisiert werden muss (siehe auch Abschnitt 2.1.6.).

– Bei Netzbetrieb.
  Prüfen ob der Netzspannungsumschalter auf die vorhandene Netzspannung eingestellt ist. Falls erforderlich den Umschalter für die entsprechende Spannung einstellen, wie in Abschnitt 2.1.2. angegeben.
  Das Gerät einschalten.
– Bei externer Gleichspannung.
  Prüfen ob die externe Spannungsquelle richtig angeschlossen ist, mit Pluspol an Erde.

> **WARNUNG**
>
> EINE GROSSE HELLIGKEIT ÜBER LÄNGERE ZEIT KANN ZU BESCHÄDIGUNG DER ELEKTRONENSTRAHLRÖHRE FÜHREN.

Bei Betriebsart "Variable Persistence" warnt die Elektronenstrahlröhre selbst vor zu hoher Strahlintensität durch Leuchtspurzerfliessung. Wenn "Leuchtspurzerfliessung" auftritt ist die Helligkeit herabzusetzen, durch Knopf INTENS, R8 etwas nach links zu drehen.
Eine derartige Warnung gibs es bei Betriebsarten "MEMORY OFF" und "X-Y" nicht, daher ist äusserste Vorsicht geboten.

2.2.2.1. Verwendung als gewöhnlichen Oszillograf

– Die Speicherfunktion der Elektronenstrahlröhre lässt sich durch gleichzeitiges Eindrücken der Tasten SAVE, SK22 und READ, SK23 (MEMORY OFF Stellung) ausschalten.
– FOCUS, Knopf R9 und INTENS, Knopf R8 in Mittelposition stellen.
– BEAM SELECTOR Taste A (SK14) und B (SK15) eindrücken. Nicht vergessen, dass bei nicht eingedrückter BEAM SELECTOR Taste keine Darstellung gegeben ist.
– Wähle Triggerquelle, Flanke und Art. Wenn keine der Trigger Tasten gedrückt ist triggert der Oszillograf das Y_A Signal an der positiven Flanke in Betriebsart AUTO und ohne Pegelbegrenzung. Die beiden Elektronenstrahlen mit Hilfe der Knöpfe Y POSITION (R11 R12) auf dem Schirm darstellen.
  Der Oszillograf ist nun betriebsbereit. Für Korrektur der Gleichspannungssymmetrie siehe Abschnitt 3.2.4.2.

2.2.2.2. Verwendung als Speicheroszillograf

Ausgehend von Stellung MEMORY OFF, während mit Knopf INTENS (R8) eine brauchbare Helligkeit des Elektronenstrahls eingestellt wird und mit Knopf FOCUS (R9) eine optimale Schärfe, wird durch Drucktaste WRITE, SK25 einzudrücken Betriebsart STORAGE erlangt.

Persistence — Abhängig von der Stellung des Potentiometers PERSISTENCE, R10 wird eine schnell verschwindende Strahlspur auf einen grünen Hintergrund geschrieben (R10 ganz nach links) oder eine langsam verschwindende Strahlspur auf einem schwarzen Hintergrund (R10 berührt den ersten rechtsläufigen Anschlag).
Die Nachleuchtdauer ist einstellbar um bei Darstellung eines Niederfrequenz-Signals Flackern zu unterdrücken. Für ein Signal mit niedriger Wiederholungsfrequenz und kurzer Anstiegzeit, lässt sich die Nachleuchtdauer so einstellen, dass die Strahlspur ausgefüllt wird um eine deutliche und stabile Darstellung zu erhalten.

Save — Soll ein bestimmter Elektronenstrahl festgehalten werden, lässt er sich durch Eindrücken von Taste SAVE, SK22 bewahren.
Die Strahlspur ist dann gerade noch sichtbar.

Read — Die Helligkeit der gespeicherten Strahlspur wird nach Eindrücken der Taste READ, SK22 grösser, die Helligkeit wird jedoch auf Kosten der Speicherzeit erzielt.

Erase — Wird die Strahlspur nicht mehr benötigt, dann kann sie durch Eindrücken der Taste ERASE, SK23 gelöscht werden. Es kann vorkommen, dass die Strahlspur nicht gänzlich verschwindet besonders die mit beträchtlicher Helligkeit geschriebenen Teile. Dies lässt sich durch mehrmahliger Betätigung der Taste "ERASE" überwinden.

Max. Write Die Schreibgeschwindigkeit lässt sich um etwa einen Faktor 10 erhöhen. Dies geschieht durch Bedienungselement PERSISTENCE, R10 in Stellung MAX. WRITE zu bringen, das heisst den zweiten rechtsläufigen Anschlag zu berühren so dass SK27 umschaltet. Betriebsart MAX. WRITE ist für kurze Ablenkzeiten oder für Signal mit kurzer Anstiegzeit erforderlich.

2.2.3. EINGÄNGE Y_1 UND Y_2 UND IHRE MÖGLICHKEITEN

Der Oszillograf PM 3234 besitzt zwei identische Vertikalkanäle, die entweder zusammen mit dem Zeitablenkgenerator für Y-T-Messungen oder aber für X-Y-Messungen bis 1 MHz verwendet werden können, sowie die Möglichkeiten die Darstellungen in verschiedenen Betriebsarten zu speichern.

2.2.3.1. Y-T-Messungen

Zur Darstellung eines Signals ist einer der beiden vertikalen Kanäle mit BEAM SELECTOR A SK14 oder BEAM SELECTOR B SK15 zu wählen. Wenn beide Tasten A SK14 und B SK15 gedrückt werden, können zwei Signale gleichzeitig abgebildet werden. Der Ablenkkoeffizient lässt sich für jeden Kanal getrennt einstellen.

2.2.3.2. X-Y-Messungen

Wenn Schalter SK2 TIME/Div in Stellung X via Y_A steht, ist der Zeitablenkgenerator ausgeschaltet. Das Signal des Y_A-Kanals wird nun horizontal abgebildet. Mit den Bedienungselementen für Y_A, ausgenommen Potentiometer R11 POSITION, wird nun die X-Ablenkung eingestellt. Nur für die Verschiebung des Elektronenstrahls in horizontaler Richtung muss Potentiometer R1 X POSITION verwendet werden. Die fünffache Dehnung mit Schalter SK5 ist jedoch ausser Betrieb.
Bei dieser Einstellung sind X-Y-Messungen bis zu 100 kHz möglich.

2.2.3.3. Funktion des Schalters AC-0-DC

Die zu untersuchenden Signale sind an den Y_A-Eingang BU3 bzw. den Y_B-Eingang BU5 anzuschliessen. Je nach Zusammensetzung des Signal ist der Schalter AC-0-DC in Stellung AC oder DC zu setzen. In Stellung DC ist der Eingang direkt mit dem Y-Verstärker verbunden. Da der Y-Verstärker gleichspannungsgekoppelt ist, steht die ganze Bandbreite des Gerätes zur Verfügung. Das bedeutet, dass das vollständige Eingangssignal an die Ablenkplatten gelangt, einschliesslich einer evt. Gleichspannungskomponente, die den Strahl auf dem Schirm verschiebt.
Falls kleinere Wechselspannungen hohen Gleichspannungen überlagert sind, kann deren Darstellung zu Schwierigkeiten führen. Um in solchen Fällen die Wechselspannung sichtbar machen zu können, muss das Eingangssignal start abgeschwächt werden, wodurch der Wechselspannungsanteil nur sehr klein wiedergegeben wird.
In diesem Fall ist der Schalter AC-0-DC auf AC zu stellen.
Nun liegt ein Trennkondensator zwieschen der Eingangsbuchse und dem Y-Verstärker, der Gleichspannungen zurückhält, aber ausserdem die sehr tiefen Frequenzen unterdrückt bzw. etwas abschwächt.
Bei Rechtecksignalen mit sehr niedriger Frequenz ist eine Dachschräge der Impulse dabei nicht zu vermeiden.
In Stellung 0 des Schalters AC-0-DC kann man schnell den Nullpegel bestimmen. In dieser Stellung ist der Verstärkereingang nicht mit dem Eingangssignal verbunden, sondern geerdet. Gleichzeit wird der Trennkondensator entladen, damit die zu prüfende Schaltung nicht beschädigt werden kann.

2.2.4. TRIGGERUNG

2.2.4.1. Allgemeines

Um ein stellstehendes Bild zu erhalten, muss die horizontale Ablenkung immer beim selben Punkt des Signals gestarted werden. Deshalb wird der Zeitablenkgenerator von einem kurzen Triggerimpuls gestartet, der in der Triggereinheit (Schmitt-Trigger) geformt und von einem Signal gesteuert wird, das dem vertikalen Eingangssignal oder einer externen Spannungsquelle entnommen wird.

2.2.4.2. Triggerkopplung

AC Wenn das Eingangssignal eine Gleichspannungskomponente enthält, kommt es vor, dass mit dem Pegelpotentiometer nicht der richtige Gleichspannungspegel für den Schmitt-Trigger eingestellt werden kann. In diesem Fall ist mit Wechselspannungskopplung zu arbeiten. Die Wechselspannungskopplung erhält man durch Einfügen eines Kondensators in die Triggerleitung. Dies hat den Vorteil, dass trotzdem Gleichspannungskopplung für die Y-Kanäle erhalten bleibt.

DC Eine Gleichspannungskopplung ist zweckmässig, wenn der Mittelwert des Signals schwankt. Diese Art von Signalen tritt oft in Digitalsystemen auf. Bei Wechselspannungskopplung würde der Triggerpunkt dann nicht festliegen, wodurch das Oszillogramm zu zittern beginnt oder die Triggerung ganz ausfällt.

2.2.4.3. Triggerpegel

Bei einem komplizierten Signal mit meheren periodisch auftretenden nicht identischen Spannungsformen muss die Zeitablenkung immer bei derselben Spannungsform gestartet werden, um ein stillstehende Oszillogramm zu erhalten. Dies ist möglich, wenn irgenein Teil des Kurvenzuges eine abweichende Amplitude hat. Mit dem Knopf LEVEL kann der Triggerpegel so eingestellt werden, dass nur diese grössere Spannungsabweichung den eingestellten Pegel überschreitet.
Die Pegeleinstellung ist auch sehr nützlich, wenn zwei Signale genau verglichen werden sollen, z.B. bei Phasenmessungen. Mit der Pegeleinstellung kann der Startpunkt der beiden Kurven so gegeneinander verschoben werden, dass er auf der mittleren Rasterlinie liegt.

2.2.4.4. Automatische Triggerung

Die automatische Triggerung – Schalter AUTO gedrückt – wird wegen der einfachen Bedienung am häufigsten gewählt. Bei dieser Triggerart können die verschiedenartigsten Signalformen abgebildet werden, ohne dass irgendeines der Triggerbedienungsorgane eingestellt werden muss. Wenn kein Triggersignal vorhanden ist, bleibt auf dem Schirm eine Nullinie sichtbar und erleichtert damit den Nullpunktvergleich. Bei dieser Triggerart lässt sich der Pegel über den Spitze-Spitze-Wert der Wechselspannungskomponente des Signals einstellen. Wenn keiner der Schalter AUTO, AC, oder DC gedrückt ist, triggert der Oszillograf automatisch, aber über den gesamten zur Verfügung stehenden Pegelbereich. Dies hat den Vorteil, dass immer eine Linie auf dem Schirm zu sehen ist, auch wenn keine der Triggertasten gedrückt ist.

2.2.4.5. Externe Triggerung

Mit externer Triggerung wird bei Signalen mit stark schwankender Amplitude gearbeitet, sofern ein Signal mit konstanter Amplitude und gleicher Frequenz zur Verfügung steht. Noch wichtiger ist die externe Triggerung bei komplexen Signalen und Impulsmustern, um Doppelbilder zu vermeiden.
Man braucht dann nicht bei jeder Änderung des Eingangssignals den Triggerpegel neu einzustellen.

2.2.4.6. Triggerung mit Netzfrequenz

In diesem Falle ist das Triggersignal eine Sinusspannung mit Netzfrequenz. Diese Triggerquelle kann verwendet werden, wenn das zu untersuchende Signal mit der Netzfrequenz gekoppelt ist; z.B. zur Untersuchung der Brummkomponente eines Signals.

2.2.4.7. Stellung SINGLE und Verwendung der Knopfes "RESET"

Wenn einmalige Vorgänge beobachtet werden müssen, empfiehlt es sich oft, sicherzustellen, dass nur ein Sägezahn erzeugt wird, selbst wenn die Möglichkeit bestünde, nach Darstellung dieses Vorgangs verschiedene Triggerimpulse zu erzeugen. Der betreffende einmalige Sägezahn soll selbstverständlich von einem Triggerimpuls getriggert werden.
Hierzu den Betriebsartenschalter in Stellung SINGLE bringen.
Der erste Impuls, der nach Betätigung des Knopfes RESET erscheint, startet den Zeitablenkgenerator.
Das Bild wird nur einmal geschrieben. Die Zeitablenkung wird dann blockiert, bis Knopf RESET wieder betätigt wird.
Die Lampe in Knopf RESET leuchtet auf, sobald dieser Knopf betätigt wird und erlischt, sobald der Sägezahn beginnt.

2.2.5. DEHNUNG DER ZEITABLENKUNG

Die Dehnung wird mit einem Schiebeschalter eingestellt. Wenn dieser Schalter sich in Stellung x5 befindet, ist die Zeitablenkung auf das 5-fache erweitert. In dieser Stellung gilt der eingestellte Zeitmassstab geteilt durch 5.

2.2.6. DIE ZWEISTRAHL-SPEICHERRÖHRE

2.2.6.1. Speicher Prinzip

Der PM 3234 Oszillograf enthält eine Elektronenstrahlröhre mit einem Speichernetz mit variabler Speicherzeit. Daher kann die Elektronenstrahlröhre wie jede normale verwendet werden, jedoch mit veränderlicher Nachleuchtdauer des dargestellten Signals.

Information wird durch Schreiben des Signals des Hauptelektrodenstrahls auf eine SPEICHERSCHICHT aus nicht leitendem Material gespeichert. Als Folge der Sekundäremission von Elektronen aus dieser Schicht wird ein positives Ladungsmuster aufgebaut. Dieses Ladungsmuster wird auf der Oberfläche der Speicherschicht längere Zeit instandgehalten, auch noch nach Ausschalten der Schreibkanone.
Die Strahlspur wird auf dem Leuchtschirm mit Hilfe eines zweiten Elektronenstrahls, dessen Elektronen über den positive aufgeladenen Teil der Speicherschicht auf den Phosphor auftreffen, reproduziert.

Speicherung von Information auf nicht leitendem Material ist auf Sekundäremission basiert. Abb. 2.4. zeight das Verhältnis zwischen der Zahl der aus der Speicherschicht herausgeschlagenen Elektronen und der Zahl der auftreffenden Elektronen (Sekundäremissionsverhältnis) gegenüber dem Oberflächenpotential. Bei einem bestimmten Oberflächenpotential, V_a in Abb. 2.4., ist die Zahl der herausgeschlagenen und der auftreffenden Elektronen gleich. Diesen Punkt nennt man den ersten "cross-over" (Sekundäremissionsverhältnis = 1).

Wenn auf die Speicherschicht Elektronen von hoher Energie (Elektronen mit hoher Geschwindigkeit) auftreffen dann wird die Oberfläche positiver, da mehr Elektronen herausgeschlagen werden als Elektronen auftreffen. Wird die Oberfläche von Elektronen niedriger Energie getroffen (Elektronen mit niedriger Geschwindigkeit) als bei V_a, dann wird das Oberflächen-Potential negativer, da weniger Elektronen herausgeschlagen werden als auftreffen.

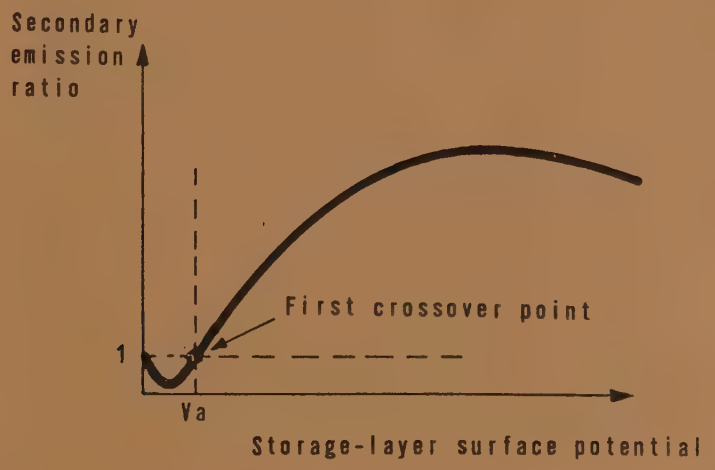


Abb. 2.4. Sekundäremisionsverhältnis-Kurve

2.2.6.2. Konstruktion und Betrieb der Speicher-Elektronenstrahlröhre

Die Zweistrahl Speicher-Elektronenstrahlröhre umfasst zwei Systeme: das Schreibsystem und das Flutsystem.

Das Zweistrahl Schreibsystem enthält eine Kanone in der zwei Strahlen erzeugt werden die unabhängig abgelinkt werden. Diese Anordnung ist als Spaltstrahlsystem (split-beam) bekannt. Bei dieser Röhre laufen beide Zeitablenklinien absolut parallel, da sie an einem Punkt erzeugt und von einem gemeinsamen Horizontal-verstärker beeinflusst werden. Da beide Strahlen in einer Kanone erzeugt werden, sind sie gegeneinander nur gering verzerrt.
Das Flutsystem besteht aus einem Paar parallel betriebenen FLUTKANONEN. Beide Kanonen enthalten eine KATHODE k, ein STEUERGITTER g1 und ein BESCHLEUNIGUNGSGITTER g2 (siehe Abb. 2.5). Beide Flutkanonen gemeinsam ist der FLUTSTRAHL-KOLLIMATOR g7, das KOLLEKTORNETZ g8, das SPEICHER NETZ g9 das die Speicherschicht trägt und der LEUCHTSCHIRM g10.

Die Flutkanonen befinden sich an einem Punkt vor den Horizontalablenkplatten und dem Netz. Das Kathoden-potential beträgt etwa +30 V, dies sind 50 V in negativer Richtung gegenüber dem Beschleunigungsgitter. Die beiden Flutkathoden emittieren eine Elektronenwolke. Diese Wolken von beiden Steuergittern g1 gesammelt, von beiden Beschleunigungsgittern g2 verschnellt und werden vom Kollimator, der aus einer Schicht an der Innenseite des Glasskolbens besteht, geformt. Die positive Spannung am Kollimator ist eine solche, dass die von der Flutkanone ausströmende Elektronenwolke gerate nur die Bildfläche der Elektronenstrahlröhre ausfüllt. Die Wolke wird vom Kollektornetz g8 weiter in Richtung des Speichernetzes und des Leuchtschirms beschleunigt.

Nach Durchlaufen des Kollektornetzes werden die Flutelektronen vom Potential des Speichernetzes und der Speicherschichtoberfläche gesteuert.
Abb. 2.6. zeigt eine Frontansicht der Kollektor- und Speichernetze.
Die Maschen in beiden Netzen sind ca. 40 x 40 μm. Die Kathodenseite des Speichernetzes ist mit einer Schicht nicht leitenden Materials belegt, worauf die Information gespeichert wird siehe Abb. 2.7. Mit anderen Worten, es besteht eine kapazitive Kopplung zwischen Speichernetz und Speichersichtoberfläche. Diese kapazitive Kopplung ist für eine einwandfreie Speicher- und Löschfunktion unentbehrlich.
Das Potential des Speichernetzes ist etwa +2 V in Verhältnis zum Flutkathodenpotential, das heisst +32 V gegen Masse.
Das Potential V_a der Speicherschichtoberfläche wird von an das Speichernetz gelegten Schreib- und Lösch-Signalen gesteuert und variiert zwischen 2 V positive geladen und 4 V negativ geladen in Bezug auf die Flutkathode. Wenn die Speicherschichtoberfläche ein Potential von +2 V gegenüber der Kathode besitzt (siehe Abb. 2.8) dan passiert der grösste Teil der Flutelektronen die Maschen des Netzes und gelangt an den Leuchtschirm.

Die übrigen Elektronen werden von der Speicherschichtoberfläche zurückgestossen und vom Kollektornetz angezogen. Ist das Potential der Speicherschichtoberfläche gegenüber der Kathode negativ (siehe Abb. 2.9) dann vermindert die Zahl der das Speichernetz passierenden Elektronen drastisch, oder wenn der "cut-off" Pegel erreicht wird, passieren überhaupt keine Elektronen mehr das Speichernetz.

Die Nachbeschleunigungsspannung von etwa 7 kV wird an den Leuchtschirm gelegt. Elektronen die das Speichernetz passieren können werden von diesem Potential beschleunigt und treffen mit einer derartigen Geschwindigkeit auf den Leuchtschirm auf dass ein helles Bild entsteht.

Das Speichernetz lässt sich mit dem Triodengitter vergleichen. So wie das Triodengitterpotential den Anodenstrom steuert, so steuert das Speichernetz den Strom der Flutelektronen zum Schirm und damit die Strahlhelligkeit.

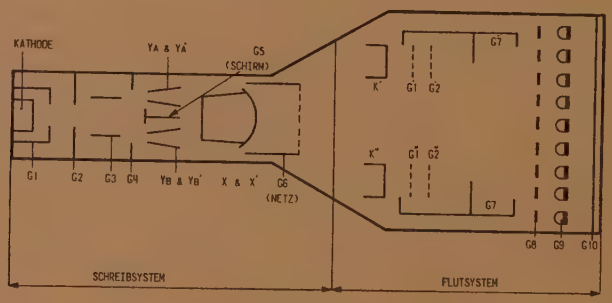


Abb. 2.5. Vereinfachtes Schaltbild der Elektronenstrahlröhre

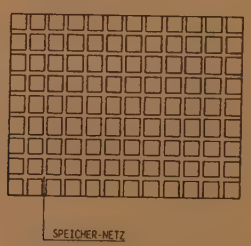


Abb. 2.6. Ausschnitt aus den Speicher- und Kollektornetzen

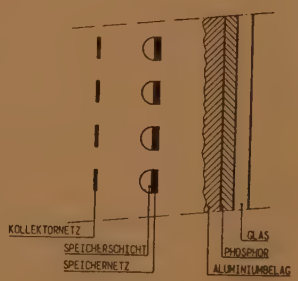


Abb. 2.7. Querschnitt des Speichersystems

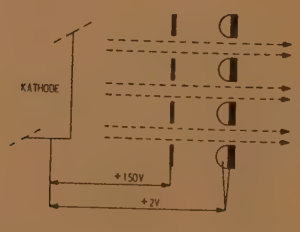


Fig. 2.8. Speichersystem mit hohem Helligkeitsgrad

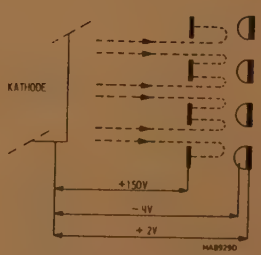


Abb. 2.9. "Cut off" des Speichersystems

2.3. Beschreibung des Blockschaltbildes (Abb. 2.10. Seite 28)

2.3.1. Y-ACHSE

Der Oszillograf PM 3234 besitzt zwei identische gleichspannungsgekoppelte Y-Verstärker, mit denen zwei Signale gleichzeitig dargestellt werden können. Jeder Verstärker enthält einen Abschwächer, einen Impedanzwandler mit Schutzschaltung, einen Vorverstärker, eine Driftkompensation, eine Triggerentnahmestufe, eine Verzögerungsschaltung und einen Endverstärker.
In diesem Gerät befindet sich die Verzögerungsschaltung (für beide Kanäle Y_A und Y_B) zwischen der Triggerentnahmestufe und dem Endverstärker, welche ein Teil der Verzögerungseinheit ist.
Die Schutzschaltung verhindert eine Beschädigung des Feldeffektransistors in der Eingangsstufe durch zu hohe Eingangsspannungen.
Die Driftkompensationsschaltung reduziert die bei hochempfindlichen Verstärkern unvermeidliche Drift.

Die Triggerentnahmestufe liefert bei interner Triggerung ein Triggersignal an den Triggervorverstärker und koppelt ausserdem das Y-Signal an den Y-Endverstärker. Wenn das Gerät als X-Y-Oszillograf verwendet wird, kann das Signal von Kanal Y_A an den X-Endverstärker angeschlossen werden. Vom Y-Endverstärker gelangt das Signal an die Y-Ablenkplatten der Elektronenstrahlröhre.
Die Verzögerungsschaltung gestattet die Wiedergabe der Vorderflanke schneller Vorgange auf dem Bildschirm.

2.3.2. TRIGGERUNG

Das Triggersignal kann entweder einem Y-Verstärker, einer externe Quelle oder intern dem Netz entnommen werden. Letzteres ist nicht möglich, wenn das Gerät mit einer externen Gleichspannung betrieben wird. Das Triggersignal kommt an den Triggerimpulsformer, der eindeutige Triggerimpulse zum Starten des Zeitablenkgenerators liefert. Die Triggereinheit enthält ausserdem eine Einzelablenkschaltung, die nach Eindrücken der Taste RESET und nach dem Eintreffen eines Triggerimpulses, macht, dass der Zeitablenkgenerator einen Sägezahn erzeugt.

2.3.3. ZEITABLENKUNG

Der Zeitablenkgenerator ist ein Konstantstromintegrator und liefert zwei Ausgangsspannungen. Eine Sägezahnspannung für den X-Endverstärker und die Ausgangsbuchse an der Rückseite des Gerätes und einen Torimpuls, der für die Helltastung der Elektronenstrahlröhre während der Ablenkung sorgt.

2.3.4. X-ACHSE

Der X-Endverstärker erhält sein Eingangssignal entweder vom Zeitablenkgenerator oder über den Y_A-Kanal von einer externen Spannungsquelle. Von X-Verstärker gelangt das Signal an die horizontalen Ablenkplatten der Elektronenstrahlröhre.

2.3.5. ELEKTRONENSTRAHLROHRENSCHALTUNG

Dieser Schaltungsaufbau enthält Schaltungen für Strahl-Austastung und Strahl-Helltastung, eine automatische Helligkeitssteuerung, Schaltungen die zu den Speicherfunktionen der Elektronenstrahlröhre gehören und Netzwerke zum Einstellen der Kenndaten der Röhre.
The A.B.C. Einheit (automatic brightness control = automatische Helligkeitssteuerung) gewährleistet eine praktisch konstante Bildhelligkeit oder eine ausgetastete Strahlspur in den verschiedenen Betriebsarten.
Bei dauernder Darstellungsart wird die Strahlspur von einem Signal des Zeitablenkgenerators ausgetastet und hellgetastet. Bei Betriebsart "SINGLE SWEEP" wird der Strahl von der A.B.C. Einheit ausgetastet.
Die Speicherschaltungen stellen die für den Speicherbetrieb der Elektronenstrahlröhre erforderlichen Spannungspegel und Signalformen zur Verfügung.
Die Einstell-Netzwerke enthalten Voreinstellungs-Potentiometer zur Korrektur von Strahldrehung, Astigmatismus, Verzerrung und Rechtwinkligkeit.
Die Hochspannungen für die Elektronenstrahlröhre werden von einem Spannungswandler erzeugt der auch die übrigen Speisespannungen liefert.

2.4. Kurze Prüfanleitung

Allgemeines: Dieses Prüfverfahren ist in MEMORY OFF Betriebsart auszuführen.
Für alle Speicherfunktionen siehe Abschnitt 3.2. (Prüfung und Einstellen)

> **WARNUNG**
> Minimale Strahlintensität verwenden um eine klare und gut sichtbare Darstellung zu erhalten. Zu hohe Intensität kann die Elektronenstrahlröhre beschädigen.

2.4.1. AUSGANGSSTELLUNG DER BEDIENUNGSORGANE

- Tasten SAVE, SK22 und READ, SK23 gleichzeitig eindrücken.
- Die Tasten Y_A SK4 + SK8 und BEAM SELECTOR A SK14 und B SK15 gedrückt.
- Schalter SK2 TIME/Div in Stellung 0,1 ms/Div.
- Schalter SK17 und SK18 AMPL in Stellung 0,1 V/Div.
- Schalter SK1 MAGN in x1.
- Potentiometer POSITION R1, R11 und R12 in ihre Mittelstellungen.
- Potentiometer INTENS, R8 für minimale Bildhelligkeit einstellen.
- Potentiometer TIME/Div und AMPL R2, R4 und R5 in Stellung CAL.

Sofern nicht anders angegeben, müssen die Bedienungsorgane sich immer in derselben Stellung wie bei der vorausgegangenen Prüfung befinden.

2.4.2. EINSTELLUNGEN DER ELEKTRONENSTRAHLRÖHRE

- Mit den Potentiometern FOCUS (R9) und INTENS (R8) eine klare und gut sichtbare Linie einstellen.
- Die beiden Zeitablenklinien mit den Potentiometern POSITION (R1, R11 und R12) zentrieren.
- Prüfen, ob die Zeitablenklinie genau parallel zu den waagerechten Rasterlinien verläuft. Eine Korrektur ist mit Potentiometer R813 möglich (Abb. 3.16.).
- Die Helligkeitsgleichheit der beiden Strahlen prüfen.
  Korrektur ist mit Hilfe der Schraube T an der Rückseite des Gerätes möglich (Abb. 2.1.).

2.4.3. Y-KANÄLE

Es wird die Prüfung von Kanal Y_A beschrieben, die für Y_B geltenden Werte stehen in Klammen.

- BEAM SELECTOR B SK15 (A SK14) lösen.
- Schalter AC-0-DC SK16 und SK19 in Stellung 0.
- Schalter AMPL SK17 (SK18) in Stellung 2 mV/Div.
- Prüfen, ob die Zeitbasislinie innerhalb 0,2 Div von der Schirmmitte bleibt. Korrektur mit Potentiometer DC BAL R6 (R7).
- Schalter AC-0-DC SK16 (SK19) in Stellung DC.
- Prüfen, ob die Zeitbasislinie nicht mehr als 0,4 Div springt.
  Korrektur mit Potentiometer R126 (R326), Abb. 3.19.
- Schalter AMPL SK17 (SK18) in Stellung 0,1 V/Div.
- Eine Rechteckspannung von 600 mV_{ss} ±0,5%, 2 kHz, an die Eingangsbuchse Y_A (Y_B) BU3 (BU5) anschliessen.
- Prüfen, ob die Höhe des Oszillogramms 6 Div ±2 % beträgt.
  Korrektur mit R111 (R311), Abb. 3.18.
- Frequenz der Eingangsspannung auf 10 MHz erhöhen.
- Prüfen ob die Höhe des Oszillogramms mindestens 4,2 Div beträgt.

2.4.4. X VIA Y_A

- BEAM SELECTOR A SK14 und B SK15 drücken.
- Schalter TIME/Div SK2 in Stellung X via Y_A.
- Schalter AC-0-DC SK19 in Stellung 0.
- Eine Rechteckspannung von 600 mV_{ss} ±0,5 %, 2 kHz, an Eingang Y_A BU3 anschliessen.
- Prüfen, ob die Breite des Oszillogramms 6 Div ±3 % beträgt.
  Korrektur mit Potentiometer R601 (Abb. 3.17.).

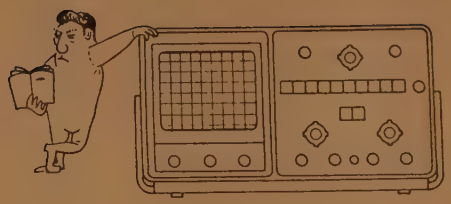
2.4.5. ZEITABLENKUNG

- Den Zeitmassstab in Stellung 20 μs des Schalters TIME/Div SK2 mit Zeitmarken prüfen, Toleranz ±5 %.
  Korrektur mit Potentiometer R534 (Abb. 3.17.).
- Die übrigen Zeitmassstäbe prüfen, Toleranz ±5 %.

2.4.6. TRIGGERUNG

- Eine Sinusspannung von 100 mV_{ss} 10 MHz, an Eingang Y_A BU3 anschliessen.
- Prüfen, ob sich mit Hilfe von Potentiometer LEVEL R3 ein stillstehendes Bild einstellen lässt.

1. GENERALITES



1.1. Introduction

L'oscilloscope (à mémoire) PM 3234 10 MHz a été conçu pour l'usage en laboratoire, l'entretien et l'éducation.
Les amplificateurs verticaux sont équipés d'un circuit de réduction de dérive, d'une ligne à retard et d'une entrée à transistor à effet de champ complètement protégé contre la surcharge.
Tous les circuits sont entièrement transistorisés et les transistors sont montés sur support pour permettre un entretien rapide.
L'oscilloscope peut être alimenté en alternatif secteur ou en continu par une source externe.
Le PM 3234 est equipé d'une unité de ligne à retard qui produit un retard de signal pour les voies Y_A et Y_B.
Des formes d'onde sont mémorisées dans le PM 3234 à l'aide d'un canon d'électrons conventionnel, afin d'obtenir une charge sur la couche-mémoire. Cette charge est maintenue une période de temps considérable, même si l'appareil est hors-service.
Le temps d'affichage d'une image mémorisée dépend du degré de luminosité choisi et peut s'élever à plus de 2 heures. Il est possible de mémoriser plusieurs formes d'onde monocourse en vue de leur représentation simultanée.
A noter la présence du bouton ERASE, lequel permet d'effacer à tout instant le tracé mémorisé, et ce immédiatement. Le PM 3234 est également pourvu d'une commande de persistance variable sur une gamme étendue. Ceci permet une représentation stable de signaux répétés à faible vitesse, sans clignotement. De plus, des signaux HF rapides sont faciles à représenter. Dans ce cas, plusieurs cycles sont nécessaires au développement de l'image sur la couche-mémoire, et ce afin d'obtenir une image nette. De telles représentations peuvent être obtenues à partir de signaux à taux de répétition d'un cycle par minute par exemple.
Les signaux monocourse, dont la vitesse est trop élevée pour leur représentation par oscilloscope conventionnel, sont visualisés grâce à la commande MAX. WRITE. Conséquence logique de la haute sensibilité requise pour ce mode est la légère dégradation de la qualité de l'image.

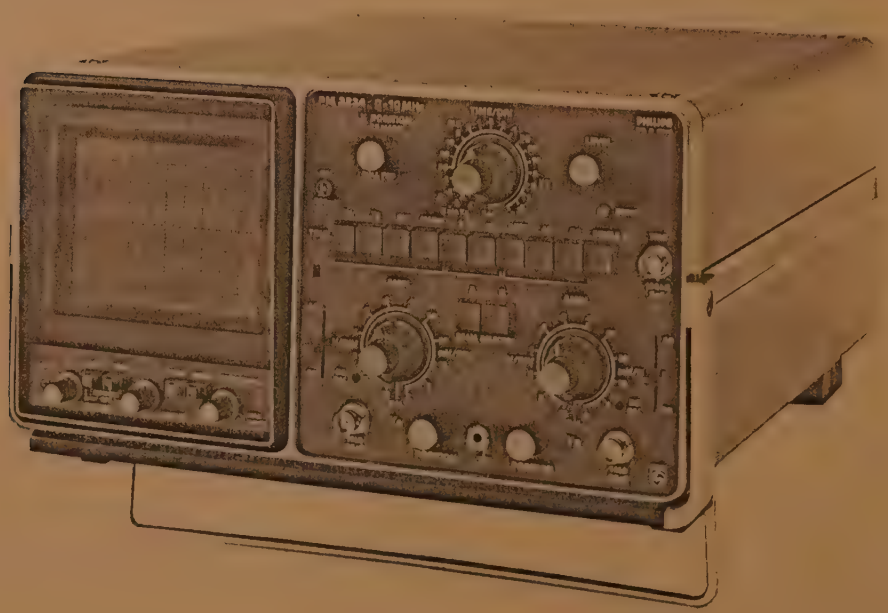


Fig. 1.1. Oscilloscope à deux faisceaux (PM 3234)

1.2. Caractéristiques techniques

Seules les valeurs indiquées avec tolérance sont garanties par l'usine pour les tensions secteur nominales. Les chiffres sans tolérance ne servent que d'orientation et correspondent aux caractéristiques d'un appareil moyen.

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.1. TUBE A RAYONS CATHODIQUES		
Type	PHILIPS L14-130GH	Tube split-beam, gaze, post-accélérateur, phosphore, doublé de métal, mémorisation de demi-tonalité
Aire de mesure	8x10 divisions	1 div. = 0,9 cm
Tension d'accélération totale	8,5 kV	
Chevauchement des deux Systèmes	100 %	Dans les sens horizontal et vertical
Graticule	Interne	
Gravures	Divisions 8x10 avec subdivisions sur les axes centraux. Les points indiquent 10 % et 90 % de la grille de mesure.	
Persistance	En mode MEMORY OFF, moyenne courte	Persistance naturelle du phosphore
	En mode WRITE: $< 0{,}3$ sec. à $\geqslant 1{,}5$ min.	Continuellement variable
Temps de mémorisation	En mode READ $\geqslant 3$ min. En mode SAVE $\geqslant 15$ min.	
Vitesse d'écriture	$\geqslant 100$ div/ms	En mode MEMORY OFF
	$\geqslant$ 1 div/μs	En mode MAX. WRITE
Effacement	env. 600 ms	Bouton ERASE enfoncé
1.2.2. AMPLIFICATEURS VERTICAUX		
1.2.2.1. Réponse		
Gamme de fréquence	continu à 10 MHz	–3 dB largeur de bande à couplage continu
	2 Hz à 10 MHz	–3 dB largeur de bande à couplage capacitif
Temps de montée	35 ns	
Dépassement	2 % maximum	Impulsion de test de 10 ns (temps de montée) pour 6 div. de déflexion à 1 MHz
1.2.2.2. Coefficients de déviation	2 mV/div à 10 V/div.	12 positions calibrées en progression 1-2-5 Commande continue non-calibrée 1 : $\geqslant 2{,}5$
1.2.2.3. Erreur limite	± 3 %	dans la gamme +5 °C à +40 °C
	± 5 %	dans la gamme –10 °C à +55 °C
1.2.2.4. Tension d'entrée maximale admise	±400 V	tension continue + tension alternative crête
1.2.2.5. Instabilité de la position du spot		
Dérive à long terme = dérive à court terme	0,25 div./heure	valeur typique

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.2.6. Décadrage vertical	16 div.	
1.2.2.7. Gamme dynamique	24 div.	Amplitude crête-à-crête pour signaux sinusoïdaux; distorsion négligeable jusqu'au 3 MHz
1.2.2.8. Impédance d'entrée	1 MOhm//20 pF	
1.2.2.9. Temps RC d'entrée	0,1 s	Commutateur de couplage en position A.C.
1.2.2.10. Retard de signal visible	$\geqslant$ 40 ns	Différence entre voies: 0,1 division
1.2.3. MODE X-Y	X par l'intermédiaire de Y_A	L'agrandisseur x5 est hors service
Gamme de fréquence horizontale	continu à 1 MHz 2 Hz à 1 MHz	
Déphasage	5° 1°	A 100 kHz A 10 kHz
Erreur supplémentaire pour voie Y_A	±2 % ± 3 %	dans la gamme +5 °C à +40 °C dans la gamme −10 °C à +55 °C
1.2.4. BASE DE TEMPS		
1.2.4.1. Coefficients de temps	0,5 s/div. à 0,2 μs/div.	20 positions étalonnées en progression 1-2-5 Commande continue non-calibrée 1 : $\geqslant$ 2,5.
1.2.4.2. Erreur de coefficient	±5 %	Dans la gamme −10 °C à +55 °C
1.2.4.3. Expansion		
Agrandissement	5 x	commutable, étalonné
Erreur supplémentaire	±2 % ±3 %	dans la gamme +5 °C à +40 °C dans la gamme −10 °C à +55 °C
1.2.4.4. Signal de sortie de base de temps		
Tension de sortie	300 mV	Terminé par 50 Ohm
Forde électromotrice (tension en circuit ouvert)	6 V_{cc} (−2 V à +4 V)	La borne de sortie peut être cout-circuitée sans affecter les coefficients de temps
Résistance interne	1 kOhm	
1.2.4.5. Gamme de décadrage	Le début et la fin de la ligne de base de temps peuvent être visualisés	
1.2.5. DECLENCHEMENT		
1.2.5.1. Source	Interne: voie Y_A, voie Y_B ou fréquence secteur Externe	
1.2.5.2. Sensibilité de déclenchement	Interne $\leqslant$ 1 div. à 10 MHz Externe $\leqslant$ 1 V_{cc} à 10 MHz	Pour signaux sinusoïdaux

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.5.3. Impédance d'entrée	100 kOhm//5 pF	
1.2.5.4. Tension d'entrée maximale admise	± 400 V	Tension continue + tension alternative crête
1.2.5.5. Mode de déclenchement	Auto A.C. D.C. Single	20 Hz ... ⩾ 10 MHz 10 Hz ... ⩾ 10 MHz 0 Hz ... ⩾ 10 MHz
1.2.5.6. Gamme de niveau	Correspondant à la hauteur de trace 24 div. 24 V	En mode automatique En modes A.C., D.C. et single Externe
1.2.5.7. Gamme de fréquence de déclenchement	10 Hz à 10 MHz continue à 10 MHz 20 Hz à 10 MHz	couplage capacitif couplage continu couplage capacitif en mode automatique
1.2.5.8. Pente de déclenchement	+ ou −	

1.2.6. GENERATEUR D'ETALONNAGE

Type	Générateur d'ondes rectangulaires	
Tension de sortie	600 mV_{cc}	
Précision	±1 %	Dans la gamme +5 °C à +40 °C
Fréquence	environ 2 kHz	

1.2.7. CONDITIONS DE FONCTIONNEMENT

1.2.7.1. Alimentation	alternatif ou continu	
Gamme de tension nominale (lisible sur l'adaptateur) de tension secteur)	alternatif 90 V ... 140 V 180 V ... 265 V continu 22 V à 30 V	
Gamme de fréquence nominale	46 Hz à 400 Hz	
1.2.7.2. Température ambiante		
Gamme de référence	+5 °C à +40 °C	
Gamme de fonctionnement	−10 °C à +55 °C	
Température d'emmagasinage et de transport	−40 °C à +70 °C	
1.2.7.3. Position de fonctionnement	N'importe laquelle	
1.2.8. TEMPS DE CHAUFFAGE	5 minutes	A des conditions d'environnement constantes (non compris le temps de rétablissement; voir également section 2.1.6.).
1.2.9. CONSOMMATION	61 VA à 220 V alternatif 30 W à 24 V continu	1,25 A consommation de courant

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.10. INTERFERENCE SECTEUR	L'appareil répond à la norme VDE Störgrad K	
1.2.11. CARACTERISTIQUES MECANIQUES		
Modèle	Portable	
Dimensions	Profondeur 503 mm	Y compris le couvercle frontal
	Largeur 326 mm	Y compris poignée
	Hauteur 185 mm	Y compris pied
Poids	Environ 11,5 kg	
1.2.12. REFROIDISSEMENT	Par circulation naturelle d'air	
1.2.13. REMPLACEMENT DES COMPOSANTS	Type de production normal, transistors enfichables	

1.3. Accessoires

1.3.1. ACCESSOIRES STANDARD

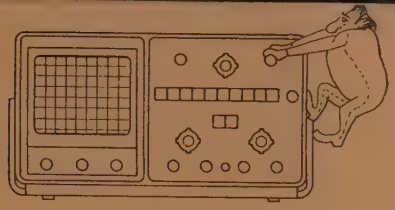
1 Couvercle frontal avec plane pour deux sondes passives et deux adaptateurs BNC 4 mm
2 Adaptateurs BNC 4 mm PM 9051
1 Notice d'emploi et d'entretien

1.3.2. ACCESSOIRES FACULTATIFS

Sondes passives (10 : 1)	: PM 9326 et PM 9327
Sondes passives (10 : 1)	: PM 9336 et PM 9336L
Sonde passive (1 : 1)	: PM 9335 et PM 9335L
Sonde passive 2 kV (100 : 1)	: PM 9358
Alimentation de sonde	: PM 9346
Sonde microminiature active (10 : 1)	: PM 9352
Sonde FET active (2 : 1)	: PM 9353
Sonde de courant	: PM 9355
Pincette miniatures pour sondes	: PM 9333
Appareil de photographie d'oscillogrammes	: PM 9380
Adaptateur (oscilloscope - PM 9380)	: PM 9379
Set de montage en rack 19"	: PM 9359

Voir également chapitre 3.5. "Information concerning accessories".

2. MODE D'EMPLOI



2.1. Installation

2.1.1. DEPOSE ET REPOSE DU COUVERCLE FRONTAL

Dépose: – Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche
– Enlever le couvercle

Repose: – Aligner la clef du bouton de verrouillage avec la fente pratiquée dans la plaque de texte de l'appareil
– Fixer le couvercle à l'avant de l'oscilloscope
– Enfoncer le bouton et le tourner d'un quart de tour vers la droite.

ATTENTION

Cet appareil produit de hautes tensions et ne peut être utilisé avec les couvercles déposés. La fiche secteur ou la source de tension externe doit être déconnectée avant tout entretien et tous les points a haute tension déchargés.

2.1.2. ADAPTATION AU SECTEUR ET FUSIBLES

Avant l'enclenchement, l'instrument doit être reglé sur la tension secteur locale à l'aide de l'adaptateur de tension situé à l'arrière de l'instrument.
Il est possible de régler l'instrument sur 110 V, 127 V, 220 V et 240 V à l'aide d'un tournevis. La tension sélectionnée est visible par l'ouverture à l'arrière.
L'instrument peut être adapté en option sur 100 V, 120 V, 200 V et 220 V à l'aide d'un transformateur spécial.
Le porte-fusible à l'arrière est normalement muni d'un fusible secteur 400 mA à action différée; cependant, si l'appareil est branché à une tension secteur intérieure à 200 V, un fusible de 800 mA doit être monté.
Vérifier si le fusible approprié est montré avant de brancher l'oscilloscope au secteur. L'usage de fusibles réparés et le court-circuitage des porte-fusibles sont strictement défendus.

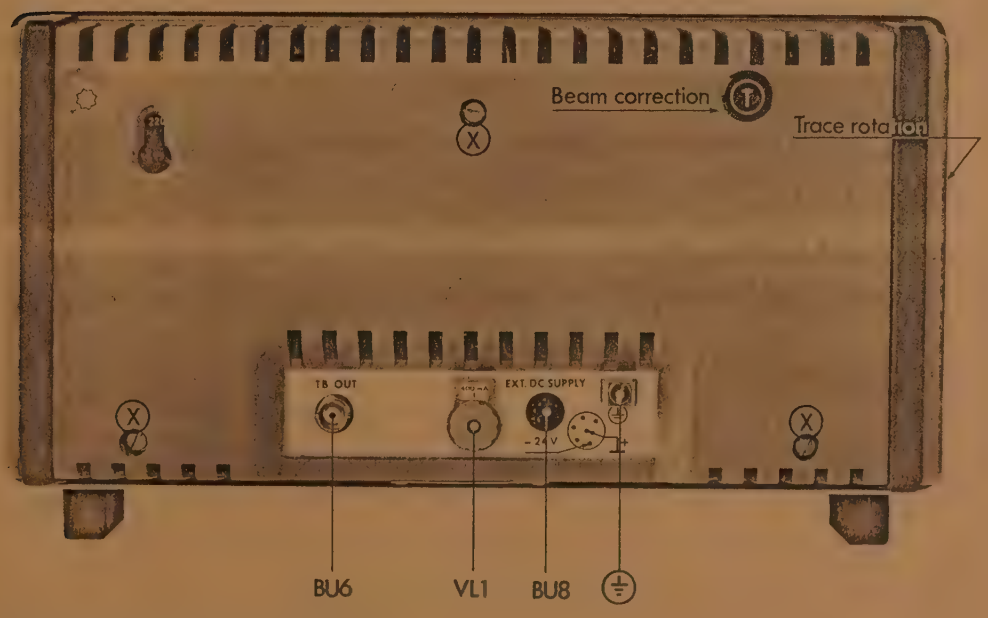


Fig. 2.1. Vue arrière montrant les douilles

2.1.3. ALIMENTATION PAR UNE SOURCE CONTINUE EXTERNE

L'appareil peut être alimenté par une source continue externe de 22 V à 30 V; 0,85 A. Cette tension doit être appliquée à la douille BU8 EXT. D.C. SUPPLY.
LA BORNE POSITIVE DE LA SOURCE DE TENSION DOIT ETRE CONNECTEE A LA TERRE. ETANT DONNE QUE LA PARTIE POSITIVE DE L'ALIMENTATION EST CONNECTEE AU CHASSIS.
L'appareil est protégé contre la connexion inverse. En cas d'alimentation continue externe, l'appareil est protégé par le fusible VL802 (Fig. 2.2.) sur la platine d'alimentation et accessible après dépose du couvercle arrière VL802 est un fusible 1,6 A à action différée.

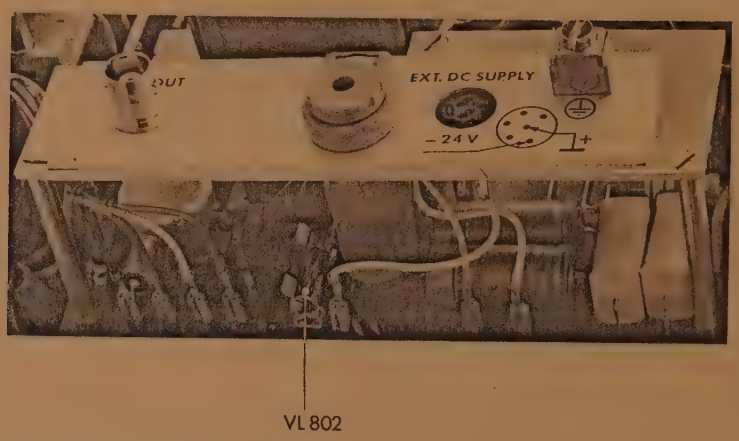


Fig. 2.2. Vue arrière montrant le fusible VL802

2.1.4. MISE A LA TERRE

Pour la sécurité l'oscilloscope doit être connecté à la terre par l'intermédiaire de la borne de terre arrière (symbole ⏚) ou du cordon secteur à condition que la douille d'alimentation soit équipée d'une connexion de terre.
Faire en sorte que la ligne de terre vers l'oscilloscope ne soit pas interrompue par l'usage d'un câble ou d'un dispositif de prolongement non raccordé à un conducteur à la terre.

2.1.5. ENCLENCHEMENT

En cas de branchement au secteur, l'appareil est enclenché par le commutateur secteur de la commande INTENS.
Le cordon secteur est placé dans un compartiment au fond de l'appareil.

En cas d'alimentation continue externe, le commutateur secteur n'a aucune fonction et l'appareil est enclenché dès que la source externe est connectée. Dans les deux cas, la position enclenchée est indiquée par la lampe témoin blanche. L'appareil peut être utilisée dans toutes les positions en tenant compte toutefois de la bonne circulation d'air. Pour les conditions thermiques, voir section 1.2.7.2.

2.1.6. PASSAGE D'UN ENDROIT FROID DANS UN ENDROIT CHAUD

A la section 1.2. il est spécifié que l'appareil fonctionne dans les limites des spécifications après une période de chauffage de cinq minutes et à une température ambiante entre +5 °C et +40 °C.
Il y a cependant une exception. Si, après avoir laissé l'oscilloscope dans sa voiture alors qu'il gèle, on le place le lendemain matin dans une pièce à 25 °C, il y aura condensation sur les composants.

Les résistances à haute impédance perdent leur propriété ohmique du fait des courants de fuite dus à la condensation; dans ce cas, l'oscilloscope ne fonctionne pas selon les spécifications. Il faut alors attendre environ deux heures avant que la condensation soit éliminée et que l'oscilloscope puisse être utilisé.

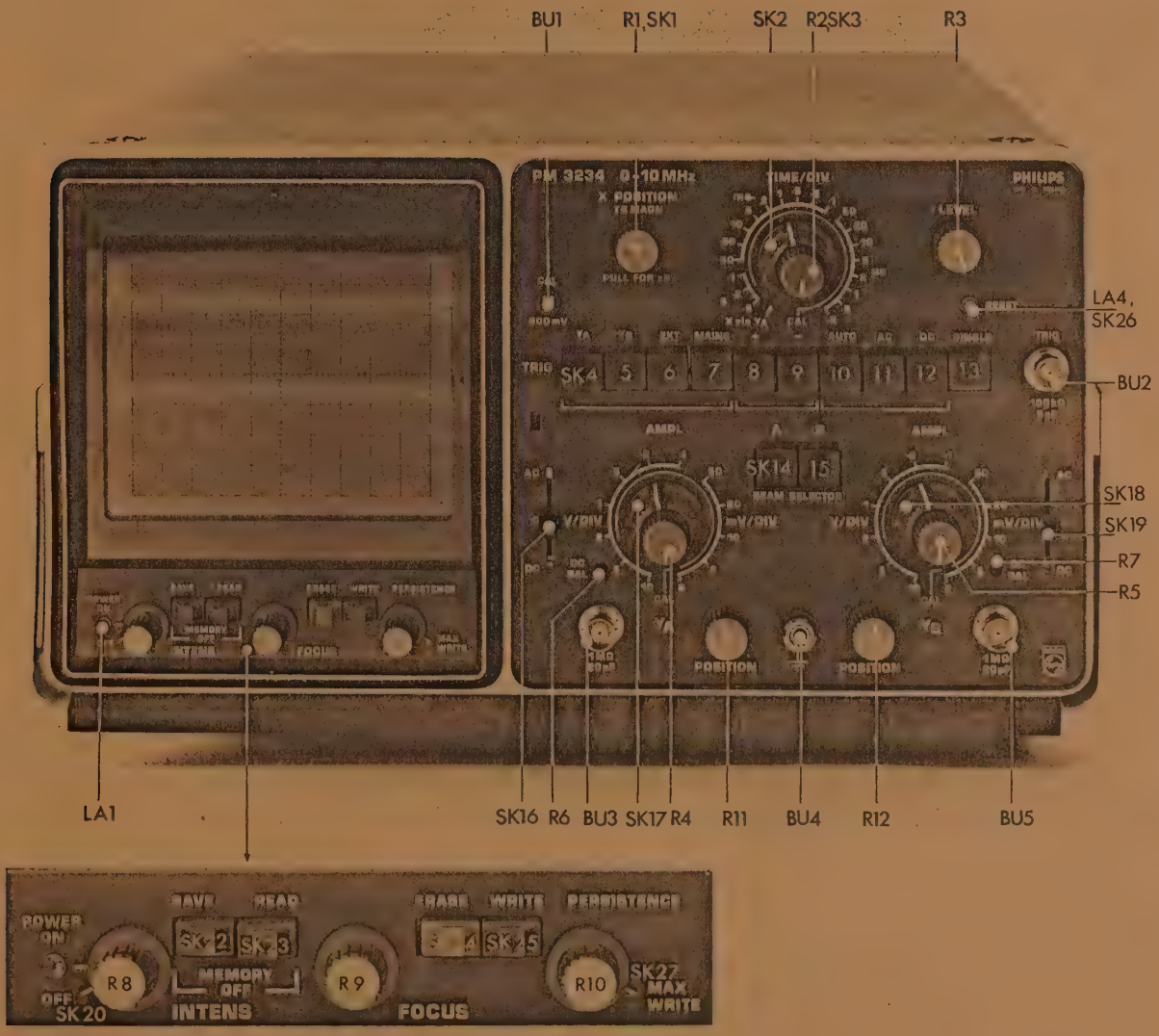


Fig. 2.3. Vue frontale montrant les commendes et douilles

2.2. Manipulation

Avant l'enclenchement s'assurer que l'oscilloscope a été installé correctement conformément au chapitre 2.1. Installation, et que toutes les précautions ont été prises.

2.2.1. COMMANDES ET DOUILLES (Fig. 2.3.)

X POSITION (R1)	Commande continuellement variable pour positionnement horizontal de la représentation.
MAGN. (SK1)	Cette commande comporte un commutateur pour agrandissement 5x de la base de temps.
TIME/div (SK2)	Commande de coefficient de temps de la base de temps; commutateur à 21 positions, dont une position pour déviation externe X (X via Y_A).
CAL. - TIME/div. (R2/SK3)	Commande continuellement variable des coefficients de temps. En position CAL. les coefficients de temps sont étalonnés.
LEVEL (R3)	Commande continuellement variable afin de sélectionner le niveau auquel le générateur de base de temps démarre.
CAL. (BU1)	Sortie pour tension rectangulaire de 600 mV_{cc} à des fins d'étalonnage.
TRIGGERING (SK4...13)	Commandes pour source, pente et mode de déclenchement; bouton-poussoir à 10 positions.
Y_A (SK4)	Signal de déclenchement interne dérivé du canal Y_A
Y_B (SK5)	Signal de déclenchement interne dérivé du canal Y_B
EXT. (SK6)	Signal de déclenchement dérivé d'une tension appliquée à la douille d'entrée TRIGG.
MAINS (SK7)	Signal de déclenchement dérivé d'une tension interne avec la fréquence secteur. Cette source de déclenchement n'exerce aucune fonction lorsque l'appareil est alimenté par une tension continue externe.
+ (SK8)	Pour déclenchement sur la pente positive du signal.
– (SK9)	Pour déclenchement sur la pente négative du signal.
AUTO (SK10)	Pour base de temps libre en l'absence de signaux de déclenchement et de limitation automatique de la gamme de commande LEVEL.
AC (SK11)	Déclenchement avec condensateur de couplage sur le chemin du signal de déclenchement.
DC (SK12)	Couplage direct pour déclenchement sur une tension variat lentement ou largeur de bande totale.
SINGLE (SK13)	Si ce bouton est enfoncé, l'instrument fonctionne en mode de balayage SINGLE.
RESET (SK26)	Si le bouton SINGLE est enfoncé, la base de temps n'est actionnée qu'après avoir enfoncé RESET à la réception d'une impulsion de déclenchement.
TRIGG (BU2)	Connecteur BNC d'entrée pour signaux de déclenchement externe.
BEAM SELECTOR A (SK14)	Lorsque ce bouton-poussoir est enfoncé, la déviation verticale s'obtient par le signal appliqué à l'entrée de voie Y_A.

BEAM SELECTOR B (SK15)	Lorsque ce bouton-poussoir est enfoncé, la déviation verticale s'obtient par le signal appliqué à l'entrée de voie Y_B. Si les commutateurs A (SK14) et B (SK15) sont tous deux enfoncés, la déviation verticale par le signal appliqué à l'entrée de voie Y_A et par celui appliqué à l'entrée de voie Y_B.
AC-0-DC (SK16 et 19)	Commutateur à trois positions pour couplage de signal AC : par l'intermédiaire d'un condensateur de couplage 0 : interruption de la connexion entre la douille d'entrée et le circuit d'entrée, ce dernier étant mis à la terre DC : couplage direct
AMPL. (SK17 et 18)	Commande des coefficients de déviation, cummutateur à 12 positions.
CAL.-AMPL. (R4 et 5)	Commande continuellement variable des coefficients de déviation verticale. En position CAL, le coefficient de déviation est étalonné.
DC BAL. (R6 et 7)	Commande continuellement variable pour balance de tension continue de l'amplificateur vertical.
INTENS (SK20 et R8)	Commande continuellement variable de l'intensité de trace. Comprend l'interrupteur secteur.
SAVE (SK22)	Permet de stocker l'onde enregistrée pour un temps de visualisation plus long (protégé contre effacement accidental)
READ (SK23)	Permet d'observer l'onde enregistrée (protégé contre effacement accidental)
MEMORY OFF (par ex. SAVE et READ enfoncés simultanément)	Permet le fonctionnement normal de l'appareil.
FOCUS (R9)	Commande continuellement variable de la focalisation du faisceau électronique
ERASE (SK24)	Efface le tracé stocké, mais pas en modes SAVE et READ où le condition ERASE est non-active.
WRITE (SK25)	Enregistre la forme d'onde; fonctionne en mode PERSISTENCE
PERSISTENCE (R10 et SK27)	Permet la rétention variable de l'onde enregistrée. Comprend le commutateur MAX. WRITE
MAX. WRITE	Permet d'accroître la vitesse d'écriture d'un facteur 10 environ.
1 MOhm — 20 pF (BU3 et 5)	Connecteur BNC d'entrée pour signaux de déviation verticale.
POSITION (R11 et 12)	Commande continuellement variable pour positionnement vertical de la réprésentation.
⏚ (BU4)	Douille de terre

A l'arrière de l'appareil (Fig. 2.1.):

TB OUT (BU6)	Connecteur BNC de sortie en dents de scie
TRACE ROTATION (R813)	Permet d'aligner la trace sur les lignes horizontale de graticule
EX.DC SUPPLY (BU8)	Douille d'entrée pour alimentation continue
Vis T	Permet d'égaliser la luminosité des deux traces

2.2.2. REGLAGES PRELIMINAIRES

Un temps de chauffage de 5 minutes est nécessaire avant de procéder à une mesure. Ce temps n'inclut pas le temps de rétablissement lorsque l'appareil sort d'un endroit froid (voir également section 2.1.6.).

- En cas d'alimentation secteur:
  Vérifier si l'adaptateur de tension est réglé sur la tension secteur locale.
  Au besoin, régler l'adaptateur sur la tension secteur appropriée conformément à 2.1.2.
- En cas d'alimentation continue externe:
  Vérifier si la source externe est connectée correctement avec borne positive à la terre.

> **ATTENTION**
> UNE FORTE INTENSITE DE LONGUE DUREE PEUT ENDOMMAGER LE TRC

En mode "Persistance variable" le TRC indique que l'intensité est trop forte par expansion du point ou de la trace. Dans ce cas, l'intensité doit être diminuée en tournant le bouton INTENS R8 légèrement vers la gauche.

En modes "MEMORY OFF" et "X-Y" une telle indication n'est pas donnée, aussie faudra-t-il faire tout spécialement attention.

2.2.2.1. Utilisation normale

- La fonction mémoire du TRC peut être déclenchée en enfonçant simultanément les boutons SAVE SK22 et READ SK23 (position MEMORY OFF).
- Mettre les commandes FOCUS (R9) et INTENS (R8) en position médiane.
- Enfoncer les boutons BEAM SELECTOR A SK14 et B SK15. Veiller à ce qu'il n'y ait pas de représentation lorsque le bouton BEAM SELECTOR n'est pas enfoncé.
- Sélectionner la source de déclenchement, la pente et le mode.
  Si le bouton TRIGG n'est pas enfoncé, l'oscilloscope déclenche au signal Y_A sur la pente positive et en mode AUTO sans limitation de gamme de niveau.
- Afficher les deux traces à l'aide des commandes Y POSITION R11 et R12.
  L'oscilloscope est alors prêt à l'usage. Pour la correction de l'équilibre continu, se référer à la section 3.2.4.2.

2.2.2.2. Utilisation mémoire

En portant de la position MEMORY OFF, le mode de stockage peut être obtenu en enfonçant le bouton-poussoir WRITE SK25, à condition que la commande INTENS R8 soit réglée pour intensité appropriée de trace et la commande FOCUS R9 sur netteté maximale.

"Persistance" — En fonction de la position du potentiomètre PERSISTENCE R10, une trace à disparation rapide est écrite sur fond vert (R10 en position extrême gauche) et une trace à disparation lente sur fond noir (R10 en position "premier arrêt droite").
La persistence peut être réglée de telle sorte que tout clignotement est supprimée à la représentation d'un signal basse fréquence. Pour un signal à faible taux de répétition et court temps de montée, la persistance peut être réglée pour remplir la trace et donc obtenir une représentation nette et constante.

"Save" — Si une trace particulière doit être retenue, on enfonce le bouton SAVE SK22. Dans ce cas, la trace est à peine visible.

"Read" — L'intensité de la trace mémorisée est accrue en enfonçant le bouton READ, SK23. à noter cependant que la luminosité augmente aux dépens du temps de stockage.

"Erase" — Lorsque la trace n'est plus nécessaire, elle peut être effacée en enfonçant le bouton ERASE SK24. Il se peut que la trace n'ait pas disparu entièrement, et plus particulièrement les parties affichées avec luminosité substantielle. Ceci peut être corrigé avec un appui prolongé sur le bouton ERASE.

"Max. write" — La vitesse d'écriture peut être accrue d'un facteur 10 environ en mettant la commande PERSISTENCE R10 en position MAX. WRITE (deuxième arrêt droite), de sorte que le commutateur SK27 est permuté.
Le mode MAX. WRITE est requis pour brefs temps de balayage ou pour signaux à court temps de montée.

2.2.3. ENTREES Y_A ET Y_B ET LEURS POSSIBILITES

Le PM 3234 est pourvu de deux voies verticales indiques pouvant être utilisés pour des mesure YT avec le générateur de base de temps ou des mesures XY pour des fréquences allant jusqu'à 1 MHz, et une possibilité de stocker les représentations dans différents modes.

2.2.3.1. Mesures YT

Pour représenter un signal, une des deux voies verticales peut être sélectionné à l'aide de BEAM SELECTOR A (SK14) ou BEAM SELECTOR B (SK15). Lorsque les deux bouton-poussoirs A et B (SK14 et SK15) sont enfoncés, deux signaux peuvent être représentés simultanément. Le coefficient de déviation Y peut être réglé individuellement pour chaque voie.

2.2.3.2. Mesures XY

Lorsque le commutateur TIME/div. SK2 est mis en position X via Y_A, le générateur de base de temps est mis hors circuit. Le signal de voie Y_A est réprésenté horizontalement. Les commandes Y_A (à l'exception du potentiomètre POSITION R11) commandent alors la déviation X. Le positionnement de la trace en sens horizontal est encore possible avec la commande POSITION R1. Le commutateur MAGNIFIER x5 (SK1) est hors service. Dans ce mode, des mesures XY sont possibles jusqu'à une fréquence de 100 kHz.

2.2.3.3. Influence du commutateur AC-0-DC

Les signaux à étudier peuvent être appliqués à la douille d'entrée Y_A (BU3) et/ou à la douille d'entrée Y_B (BU5).
Le commutateur AC-0-DC doit être réglé en position AC ou DC en fonction de la composition du signal. En position DC l'entrée est couplée directement avec l'amplificateur Y. Etant donné que l'amplificateur est couplé en continu, la largeur de bande totale de l'appareil est disponible. Ceci signifie que les tensions d'entrée totales sont conduites aux plaques de déflexion, ce qui implique que les composantes continues correspondent à des décadrages de trace sur l'écran.
Ceci peut entraîner des difficultés lorsque des signaux alternatifs superposés à de hautes tensions continues doivent être représentés.

Pour visualiser le signal alternatif dans ces cas, une plus forte atténuation est nécessaire, le signal alternatif étant alors fortement atténué.

Au cas où le commutateur AC-0-DC est en position AC, un condensateur de blocage est connecté entre la douille d'entrée et l'amplificateur Y. De ce fait, les tensions continues sont bloquées, mais les basses fréquences également sont supprimées ou atténuées. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.
En position 0 du commutateur AC-0-DC, il est possible de déterminer rapidement le niveau continu zéro. Dans cette position, la connexion entre l'entrée de l'amplificateur et la douille d'entrée est interrompue. Le condensateur de blocage est également déchargé afin d'empêcher tout endommagement du circuit testé à la suite d'une haute charge éventuelle.

2.2.4. DECLENCHEMENT

2.2.4.1. Généralités

Pour obtenir une trace stationnaire, la déviation horizontale doit toujours être démarrée à un point fixe du signal. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans une unité de déclenchement et contrôle par un signal provenant du signal d'entrée vertical ou d'une source externe.

2.2.4.2. Accouplement de déclenchement

AC Lorsque la tension du signal contient un composant continu, le déclenchement peut cesser lorsque le potentiomètre de niveau ne produit plus le niveau requis par le déclencheur de Schmitt. Dans ce cas, il est utile d'appliquer un couplage capacitif. Le couplage capacitif s'obtient en insérant un condensateur sur la piste de déclenchement. Ceci signifie que le signal de visualisation peut encore être couplé en continu avec les canaux Y.

DC Le couplage continu est utile lorsque la valeur moyenne du signal varie. Cette sorte de signal apparaît souvent dans des systèmes digitaux.
Avec le couplage capacitif le point de déclenchement n'est probablement pas fixe, ce qui entraînerait l'instabilité de la base de temps ou même une certaine perte de déclenchement.

2.2.4.3. Niveau de déclenchement

En cas de signal compliqué dans lequel un certain nombre de tensions non-identiques apparaissent périodiquement, l'axe de temps doit toujours être démarré avec la même tension, et ce afin d'obtenir une trace stationnaire.
Ceci est possible lorsqu'un des détails a une amplitude différente.
Avec le bouton LEVEL, le niveau de déclenchement peut être réglé de telle sorte que seule cette plus grande variation de tension passe ce niveau. La commande LEVEL est également très utile lorsque deux signaux doivent être comparés exactement, pour des mesures de phase par exemple. La commande LEVEL permet de décadrer le point de démarrage des traces exactement sur la ligne de graticule centrale.

2.2.4.4. Déclenchement automatique

Le déclenchement automatique (commutateur AUT enfoncé) est surtout utilisé pour sa simplicité. Dans ce mode il est possible de représenter une grande variété d'impulsions d'amplitude et de forme différentes, et ce sans devoir actionner une des commandes de déclenchement. Lorsqu'aucun signal de déclenchement n'est présent, une ligne de base de temps reste visible sur l'écran. Ceci est utile à des fins de référence du zéro. Dans ce mode de déclenchement, le niveau peut être réglé sur la valeur crête-à-crête du composant alternatif du signal. Si aucun des commutateurs AUTO, AC ou DC n'est enfoncé, l'oscilloscope fonctionne en mode automatique, la gamme de niveau totale étant alors disponible. Une trace est alors toujours visible même lorsqu'aucun bouton-poussoir TRIGG. n'est enfoncé.

2.2.4.5. Déclenchement externe

Le déclenchement externe est appliqué pour des signaux à amplitude fortement variable, lorsqu'un signal d'amplitude fixe et de fréquence égale est disponible. Le déclenchement externe est même plus important en cas de signaux et des courbes d'impulsions complexes.
Le déclenchement externe peut alors être utilisé pour éviter la double trace.
C'est pourquoi il n'est pas nécessaire de rajuster le réglage de niveau à chaque variation du signal d'entrée.

2.2.4.6. Déclenchement avec fréquence secteur

Dans ce cas, le signal de déclenchement est une sinusoïdale à fréquence secteur.
Cette source de déclenchement est utile lorsque la fréquence du signal observé est couplée avec la fréquence secteur. Par exemple, il est possible de reconnaître le composant de bruit d'un signal en déclenchant sur ce composant.

2.2.4.7. Position SINGLE et utilisation du bouton-poussoir RESET

Lors de l'observation de phénomènes n'ayant lieu qu'une fois, il est souvent recommandé de s'assurer qu'un seul balayage soit engendré, même si plusieurs impulsions de déclenchement se produisent après le phénomène en question.
Ce balayage unique doit évidemment être déclenché par une impulsion de déclenchement.
A cet effet, le commutateur de mode doit être mis en position "SINGLE". Lorsqu'on a appuyé sur le bouton RESET, l'impulsion suivante de déclenchement démarre le générateur de base de temps. Le spot n'effectue qu'un seul passage sur l'écran. La base de temps est alors bloquée jusqu'à ce que le bouton poussoir RESET soit à nouveau mis en service.
La lampe se trouvant à l'intérieur du bouton-poussoir RESET s'allume dès que ce bouton est actionné et s'éteint lorsque la dent de scie est démarrée.

2.2.5. AGRANDISSEUR DE BASE DE TEMPS

Cet agrandisseur est piloté par un commutateur push-pull. Lorsque ce commutateur est en position x5, la vitesse de balayage de la base de temps est agrandie 5 fois. Dans cette position, le temps de balayage est déterminé en divisant par cinq la valeur indiquée par TIME/div.

2.2.6. TUBE-MEMOIRE DOUBLE FAISCEAU

2.2.6.1. Principe de stockage

L'oscilloscope PM 3234 contient un tube à rayons cathodiques avec grille de stockage à temps de stockage variable. Le TRC peut donc être utilisé normalement, mais à persistance variable du signal représenté. L'information est stockée par écriture du signal faisceau principal sur une couche mémoire de matériel non-conducteur. A la suite de l'émission secondaire d'électrons par cette couche, un oscillogramme de charge positive est composé. Cet oscillogramme de charge sur la couche mémoire est retenu là pendant une durée de temps considérable, même si le canon d'écriture est hors service. La trace est retenue sur l'écran phosphore par le second faisceau dont les électrons peuvent bombarder le phosphore aux parties de couche mémoire portant une charge positive.
Le stockage de l'information sur le matériel non-conducteur est basé sur l'émission secondaire. La figure 2.4. illustre le rapport entre le nombre d'électrons sortant la couche mémoire et ceux incidents (rapport d'émission secondaire) par rapport au potentiel de surface. Pour un certain potentiel de surface V_a en Figure 2.4., le nombre d'électrons sortant la surface est égal au nombre d'électrons incidents. Ce point est appelé premier point de croisement (rapport d'émission secondaire = 1).

Si la surface de la couche mémoire est bombardée d'électrons à forte énergie (grande vitesse), la surface devient plus positive, car il y a plus d'électrons sortant qu d'électrons incidents. Si la couche mémoire est bombardée d'électrons à énergie plus faible qu'en V_a (vitesse inférieure), le potentiel de surface devient plus négatif, car il y a moins d'électrons quittant que d'électrons bombardant.

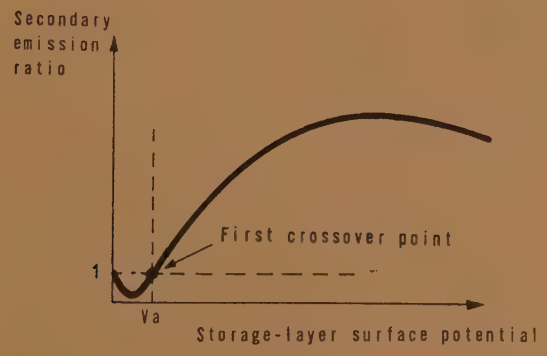


Fig. 2.4. Courbe du rapport d'émission secondaire

2.2.6.2. Construction et fonctionnement du TRC

Le tube-mémoire double faisceau comporte deux systèmes: le système d'ECRITURE et le système d'ENTRETIEN.

- La partie d'ECRITURE est formé d'un canon dans lequel deux faisceaux sont composés en vue d'une déflection indépendante. Ce dispositif est également connu sous le nom système split-beam. Dans ce tube, les deux lignes de base de temps sont exactement parallèles, car elles sont produites en un point et sous l'influence d'un amplificateur horizontal commun. Etant donné leur émission par un seul canon, les deux traces présentent une légère distorsion l'une par rapport à l'autre.
- Le système d'entretien est composé de deux CANONS DE PROJECTION actionnés en parallèle. Ces canons contiennent une CATHODE k, une GRILLE DE COMMANDE g1 et une GRILLE D'ACCELERATION g2 (voir Fig. 2.5.). Communs aux deux canons de projection sont le COLLIMATEUR g7, la GRILLE COLLECTEUR g8, la GRILLE DE STOCKAGE g9 avec couche mémoire et le LUMINOPHORE D'ECRAN g10. Les canons de projection sont placés devant les plaques de déflexion et la grille "mesh". Le potentiel de cathode est d'environ +30 V, ce qui correspond à 50 V négatif par rapport aux grilles d'accélération. Les deux systèmes de projection fournissent un nuage d'électrons. Ce nuage est combiné par les grilles de

constitue le revêtement de la surface interne du TRC. La tension positive sur le collimateur est telle que le nuage d'électrons projetés par le canon remplit exactement la surface utile du TRC.

Le nuage est ensuite accéléré vers la grille de stockage et l'écran utile par la grille collecteur g8. Après le passage par la grille collecteur, les électrons du canon de projection sont contrôlés par les potentiels de la grille et de la surface de la couche de stockage. La figure 2.6. illustre la vue frontale du collectuer

La figure 2.6. illustre la vue frontale du collecteur et des grilles de stockage. Les orifices des deux grilles sont d'environ 40 x 40 μm. Le côté cathode de la grille de stockage est revêtu d'un matériau non-conducteur sur lequel sont mémorisées les informations (voir Fig. 2.7.). Entre cette grille de stockage et la surface de la couche, il existe un couplage capacitif indispensable aux fonctions d'écriture et d'effacement. La grille de stockage est à environ +2 V par rapport à la cathode de canon de projection, par ex. environ +32 V par rapport à la terre.

Le potentiel V_a à la surface de couche mémoire est contrôlé par les signaux d'écriture et d'effacement, lesquels sont appliqués à la grille de stockage, et est variable entre 2 V positif et 4 V négatif en fonction de la cathode de canon de projection. Lorsque la surface de couche mémoire est à 2 V par rapport à la cathode (voir Fig. 2.8.), la plupart des électrons émis par les canons de projection traversent la grille et atteignent l'écran. Le reste de ces électrodes est repoussé par la surface de la couche mémoire et capté par la grille collecteur. Si le potentiel de la surface de couche mémoire est négatif par rapport à la cathode (voir Fig. 2.9.), le nombre des électrons qui traversent la grille de stockage est considérablement réduit et pour une certaine valeur (niveau "cut-off") aucun électron ne traverse la grille.

La tension de post-accélération d'environ 7 kV est appliquée à l'écran. Ainsi, dès que les électrons peuvent traverser la grille de stockage, ils sont accélérés par ce potentiel et viennent bombarder le luminophore de l'écran en provequant une émission lumineuse.

La grille de stockage peut être comparée à la grille d'une triode. Tout comme le potentiel de la grille de triode commande le courant d'anode, la grille de stockage commande le courant des électrons émis par les canons de projection sur l'écran et donc la brillance de la trace.

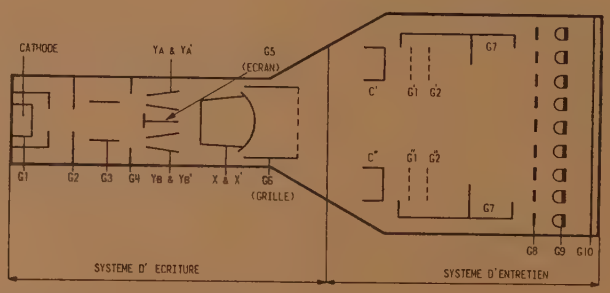


Fig. 2.5. Synoptique simplifié du tube cathodique à mémoire

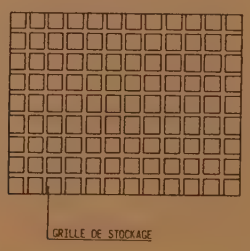


Fig. 2.6. Détail des grilles de stockage et collecteur

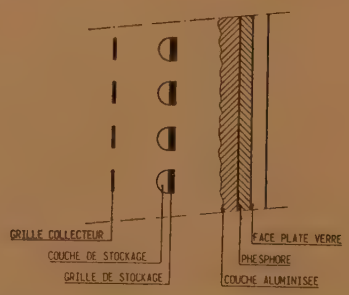


Fig. 2.7. Détail du système de mémorisation

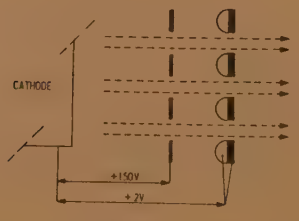


Fig. 2.8. Système de stockage à grande brillance

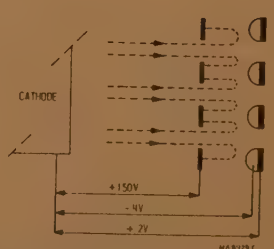


Fig. 2.9. Système de stockage au "cut-off"

2.3. Description du schéma synoptique (voir fig. 2.10. page 28)

2.3.1. AXE Y

L'oscilloscope PM 3234 est composé de deux amplificateurs verticaux indentiques à couplage continu permettant la représentation simultanée de deux signaux.
Chaque amplificateur comporte atténuateur à l'entrée, une source follower avec circuit de protection, un préamplificateur et un circuit de réduction de dérive, un étage sélectif de déclenchement, un circuit de ligne de retard et un amplificateur de sortie. L'étage sélectif de déclenchement et l'amplificateur de sortie (pour canaux Y_A et Y_B) sont couplés à l'aide du circuit de ligne à retard, qui fait partie de l'unité de ligne à retard.
Le circuit de protection empêche d'endommagement des transistors d'entrée à effet de champ à la suite d'une tension d'entrée trop élevée.
Le circuit de réduction de dérive réduit la dérive due à la haute sensibilité de l'amplificateur.
L'étage sélectif de déclenchement fournit un signal de déclenchement au préamplificateur de déclenchement en cas de déclenchement interne et accouple également le signal à visualiser l'amplificateur de sortie Y. Dans la voie Y_A le signal peut également être couplé à l'amplificateur de sortie X lorsque l'appareil est utilisé en tant qu'oscilloscope XY. Le signal est conduit de l'amplificateur de sortie Y aux plaques de déflexion Y du tube à rayons cathodiques. La ligne à retard est appliquée afin de permettre l'affichage du flanc avant de phénomènes rapides sur l'écran.

2.3.2. DECLENCHEMENT

Un signal de déclenchement peut être obtenu à partir de chaque amplificateur vertical, d'une source externe ou du secteur (interne). Le dernier signal n'est pas disponible lorsque l'appareil est alimenté par une tension continue externe. Le signal de déclenchement est conduit au conformateur d'impulsions de déclenchement lesquelles permettent le démarrage du générateur de base de temps. L'unité de déclenchement comprend un circuit de balayage simple permettant au générateur base de temps de produire une dent de scie après avoir enfoncé le bouton RESET et reçu l'impulsion de déclenchement. Ce circuit ne fonctionne que lorsque le commutateur SINGLE est enfoncé.

2.3.3. BASE DE TEMPS

Le générateur de base de temps est du type intégrateur à courant constant et fournit deux tensions de sortie. Une tension en dents de scie conduite à l'amplificateur de sortie X et à une borne de sortie à l'arrière de l'oscilloscope, et une impulsion de porte qui commande le faisceau du tube pendant le balayage.

2.3.4. AXE X

L'amplificateur de sortie X reçoit son signal d'entrée à partir du générateur de base de temps ou d'une source externe par l'intermédiaire de la voie Y_A.
Le signal est conduit de l'amplificateur X aux plaques de déviation horizontale du tube d'oscilloscope.

2.3.5. CIRCUIT DU TUBE A RAYONS CATHODIQUES

Le circuit du tube à rayons cathodiques comprend les circuits pour suppression et commande de faisceau, une unité de commande de brillance automatique, des circuits pour fonctions de stockage du tube et réseaux pour correction des caractéristiques du tube.

L'unité abc (automatic brightness control) commande de brillance automatique, assure une brillance de trace pratiquement constante ou une trace supprimée dans les différents modes d'affichage.

En mode de représentation continu, commande et suppression de trace sont obtenues par un signal émis par le générateur de base de temps. En mode de balayage simple la trace est supprimée par l'unité abc.

Les circuits de stockage fournissent les niveaux de tension et les formes d'onde nécessaires à la fonction stockage du tube.
Les régeaux de correction comprend des potentiomètres de pré-réglage pour rotation de trace, astigmatisme, distorsion et correction d'orthogonalité.

Les hautes tensions pour le tube sont produites par un convertisseur, lequel délivre également les autres tensions d'alimentation.

2.4. Bref processus de contrôle

Généralités: un bref contrôle est effectué en mode MEMORY OFF. Pour toutes les fonctions de stockage, voir chapitre 3.2. Contrôler et Réglages.

> **ATTENTION:** Utiliser une intensité minimale de faisceau afin d'obtenir une représentation nette et bien définie. Une forte intensité de longue durée peut endommager le TRC.

2.4.1. POSITIONS DE DEMARRAGE DES ORGANES DE COMMANDE

- Boutons SAVE SK22 et READ SK23 enfoncés simultanément.
- Boutons-poussoirs Y_A SK4, + SK8 et BEAM SELECTOR A SK14 & B SK15 enfoncés.
- TIME/div SK2 en position .1 ms.
- Commutateurs AMPL SK17 & SK18 en position .1 V/div.
- Commutateur MAGN SK1 en position x1.
- Potentiomètres POSITION R1, R11 et R12 en position centrale.
- Potentiomètre INTENS R8 réglés pour intensité minimale.
- Potentiomètres TIME/div et AMPL R2, R4 et R5 en position CAL.

Les organes de commande doivent être dans la même position qu'au contrôle précedent, à moins qu'indiqué différemment.

2.4.2. POSITION DU TUBE A RAYONS CATHODIQUES

- Régler les potentiomètres FOCUS R9 et INTENS R8 en position adéquate.
- Centrer les deux lignes de base à l'aide des potentiomètres POSITION R1, R11 et R12.
- Vérifier si la ligne de base de temps est exactement en parallèle avec les lignes de graticule horizontales. La correction est possible avec R813 (Fig. 3.16.).
- Vérifier l'égalité de brillance des deux faisceaux. Correction possible avec vis T à l'arrière de l'instrument (Fig. 2.1.).

2.4.3. CANAUX VERTICAUX

Seul le contrôle du canal Y_A est décrit, les éléments de canal Y_B étant indiqués entre parenthèses.

- Relâcher BEAM SELECTOR B SK15 (A SK14).
- Commutateurs AC-0-DC SK16 & SK19 en position 0.
- Commutateur AMPL SK17 (SK18) en position 2 mV/div.
- Vérifier si la ligne de base de temps reste dans les 0,2 div au centre de l'écran. La correction est possible avec le potentiomètre DC BAL R6 (R7).
- Commutateur AC-0-DC SK16 (SK19) en position DC.
- Vérifier si la ligne de base de temps n'a pas bougé de plus de 0,4 div. La correction est possible avec le potentiomètre R126 (R326), Fig. 3.19.
- Commutateur AMPL SK17 (SK18) en position .1 V/div.
- Appliquer une tension rectangulaire de 600 mV_{cc} ±0,5 %, 2 kHz à la douille d'entrée Y_A (Y_B) BU3 (BU5).
- Vérifier si la hauteur de trace est de 6 div ±2 %. La correction est possible avec R111 (R311), Fig. 3.18.
- Appliquer une tension sinusoïdale de 600 mV_{cc} ±0,5 %, 10 MHz à douille d'entrée Y_A (Y_B) BU3 (BU5).
- Vérifier si la hauter de trace est d'au moins 4,2 div.

2.4.4. X VIA Y_A

- Enfoncer BEAM SELECTOR A SK14 et B SK15.
- Mettre le commutateur TIME/div SK2 en position X via Y_A.
- Mettre le commutateur AC-0-DC SK19 en position 0.
- Appliquer une tension rectangulaire de 600 mV_{cc} ±0,5 %, 2 kHz à la douille d'entrée Y_A BU3.
- Vérifier si la largeur de trace est de 6 div ±3 %.
  La correction est possible avec le potentiomètre R601 (Fig. 3.17.).

2.4.5. BASE DE TEMPS

- Vérifier le coefficient de temps en position 20 μs du commutateur TIME/div SK2 à l'aide des marqueurs de temps. Tolérance: ±5 %. La correction est possible avec le potentiomètre R534 (Fig. 3.17.).
- Vérifier les autres coefficients de temps; tolérance ±5 %.

2.4.6. DECLENCHEMENT

- Appliquer une tension sinusoïdale de 100 mV_{cc}, 10 MHz à la douille d'entrée Y_A BU3.
- Vérifier s'il est possible de régler le potentiomètre LEVEL R3 pour représentation stationnaire.

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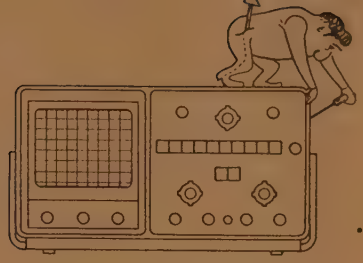
3. SERVICE DATA



3.1. Circuit description

3.1.1. CHANNEL Y_A VERTICAL AMPLIFIER

3.1.1.1. General

The vertical amplifier provides control of the input coupling, Y deflection coefficient and gain.
Furthermore, a drift-reduction circuit, a delay line and a trigger pick-off stage are part of the amplifier circuitry.

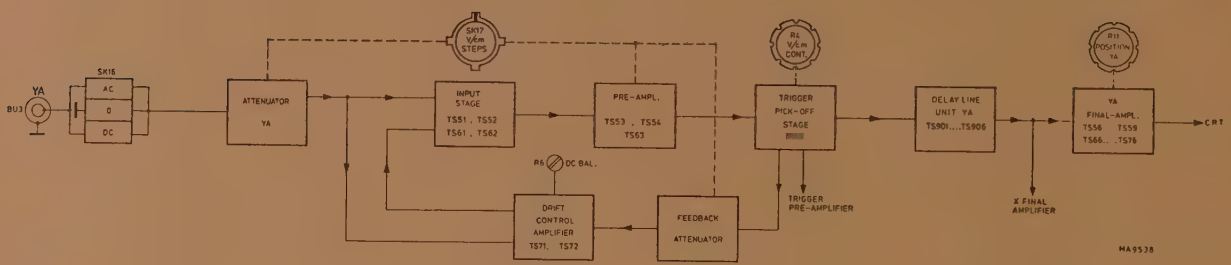


Fig. 3.1. Vertical amplifier, channel Y_A

3.1.1.2. Input coupling

Input signals connected to Y_A socket BU3 can be a.c. coupled, d.c. coupled or internally disconnected.
In position DC of AC-0-DC switch SK16, the input signal is coupled direct to the step attenuator.
In the AC position, there is a capacitor (C26) in the signal path.
This capacitor prevents the d.c. component of the input signal from being applied to the amplifier.
In position 0, the signal path between the input socket and the amplifier input is interrupted, the latter being earthed.
At the same time, blocking capacitor C26 is discharged via resistor R26, to prevent damage of the circuit under test by a possible high charge.

3.1.1.3. Input attenuator

The input attenuator is a frequency-compensated, high-ohmic voltage divider with twelve positions.
Both attenuator sections contain trimmers which are adjusted for optimum square-wave response and others that maintain the same input capacitance (20 pF) for each position of AMPL. switch SK17.
The input capacitance of both channels can be equalized using trimmer C235.
The attenuator works in conjunction with a gain control in the preamplifier (see also section 3.1.1.5.).
The gain of the pre-amplifier is selected together with the relevant attenuator section, by means of AMPL. switch SK17.

3.1.1.4. Input stage

Input source follower TS51 and emitter follower TS52 provide a high input impedance to the step attenuator and a low-impedance source to the pre-amplifier.
The input source-follower is protected by diodes GR53 and GR54 .
If there is a maximum positive-going voltage change, the field-effect transistor can deal with it. If the change goes negative beyond the threshold established by zener diode GR54, diode GR53 starts conducting and the excess is short-circuit to earth.

The non-driven part of the input stage (TS62) is decoupled for high frequencies, by means of capacitor C59. This part of the input stage receives the d.c. balance voltage and the drift-feedback voltage from the drift-feedback amplifier.

3.1.1.5. Pre-amplifier

The pre-amplifier comprises two amplifier stages, one with series feedback (TS53 & TS63) and one with shunt feedback (TS54). The overall gain of the pre-amplifier is chiefly determined by the ratio of the shunt feedback resistance (R97 & R99) and series-feedback resistance (resistance between the emitters of transistors TS53 and TS63). The latter resistance, and thus the overall gain of the pre-amplifier, can be varied by connecting resistors in parallel to resistor R62. These parallel resistors are selected, together with a section of the input attenuator, by means of AMPL. switch SK17. In this way twelve different deflection coefficients are obtained (see also section 3.1.1.3.).
Potentiometers R64 and R99 are pre-set controls for the gain of the pre-amplifier at different settings of AMPL. switch SK17.

3.1.1.6. Drift-reduction circuit

In the event of no drift phenomena in the pre-amplifier, attenuator R102, R40...R44 provides at junction R128-C67 a voltage which is exactly to, but in anti-phase with, the voltage at the gate of field-effect transistor TS51 (junction R52-R54). This is true because attenuator R102, R40...R44 is switched over together with the gain switch of the pre-amplifier. Junction R128-R52 will then be on earth level (virtual earth point).

When there is a drift phenomenon, junction R128-R52 carries half the drift voltage. This voltage is amplified by transistors TS71 and TS72 and, in the correct phase, applied to field-effect transistor TS62. The resulting feedback grings the output level of the amplifier back to 0 V. The d.c. level of the feedback is adjusted with DC BAL potentiometer R6.

In order to prevent the base currents of transistors TS71 and TS72 from flowing through high-ohmic resistors R128 and R52, they are compensated for by means of potentiometer R126 and resistors R127 and R129. Resistor R131 equalize the base impedance of transistors TS71 and TS72 .

Capacitor C59 limits the feedback at approximately 100 Hz.
Therefore, a variation of the value of potentiometers R64 & R99 causes a variation in the top of a l.f. square-wave voltage. When potentiometers R64 and R99 are correctly adjusted, the pulse top is straight.

3.1.1.6.1. Drift reduction

The drift inherent in the sensitive d.c. coupled pre-amplifier is reduced by feedback via a control amplifier. We shall now calculate the effect of the control amplifier with reference to Fig. 3.2. in which A is the gain factor of the pre-amplifier and B that of the control amplifier. Resistors R are equal.

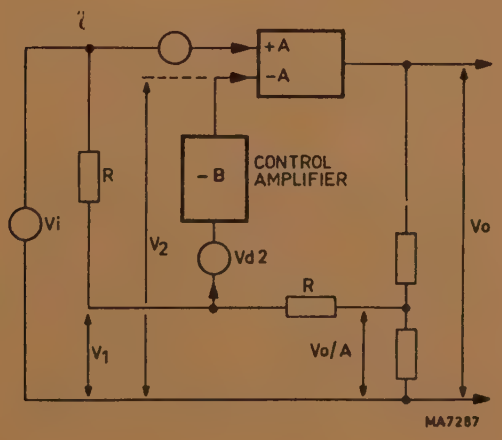


Fig. 3.2. Block diagram of the drift-reduction circuit

We regard the drift voltages from pre-amplifier and control amplifier as being due to d.c. voltage sources at the input (Vd1 and Vd2). We then find:

$$V1 = \frac{Vi + \frac{Vo}{A}}{2} \qquad (1)$$

$$V2 = -B\,(V1 + Vd2) \qquad (2)$$

$$Vo = A\,(V2 - Vi - Vd) \qquad (3)$$

It follows from (1) and (3) that:

$$V1 = \frac{Vi + \frac{A\,(V2 - Vi - Vd1)}{A}}{2} = \frac{V2 - Vd1}{2}$$

Substituting this result in (2) gives:

$$V2 = -B\,(\frac{V2 - Vd1}{2} + Vd2) \qquad \text{or}$$

$$V2\,(1 + \frac{B}{2}) = \frac{B}{2}\,Vd1 - BVd2 \qquad \text{or}$$

$$V2 = \frac{BVd1}{2+B} - \frac{BVd2}{1+\frac{B}{2}}$$

Substituting this result in (3) gives:

$$\frac{Vo}{A} = (\frac{B}{2+B} - 1)\,Vd1 - \frac{BVd2}{1+\frac{B}{2}} - Vi \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{2}{2+B}\,Vd1 + \frac{B}{1+\frac{B}{2}}\,Vd2 \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{1}{1+\frac{B}{2}}\,Vd1 + \frac{2}{1+\frac{2}{B}}\,Vd2$$

The last two terms represent drift voltages which are equivalent to a drift voltage:

$$Vd = \frac{1}{1+\frac{B}{2}}\,Vd1 + \frac{2}{1+\frac{2}{B}}\,Vd2$$

at the input.

We see that the drift of the pre-amplifiers is reduced by a factor $(1 + \frac{B}{2})$. On the other hand, we have an extra drift due to the control amplifier, which is given by $\frac{2}{1+\frac{2}{B}}\,Vd2 \approx 2Vd2$.

The drift of the control amplifier, however, is so low (because of strong thermal coupling of the amplifier transistors, and optimum design) that the term 2Vd2 can be neglected.

3.1.1.7. Trigger pick-off stage

Transistor TS64 serves a twofold purpose. It acts as an amplifier stage for the channel Y_A triggering signal further discussed in section 3.1.3.1., and as an emitter-follower for the signal to be tested.
The test signal is applied to the delay line circuit via AMPL. potentiometer R4 in the emitter circuit of transistor TS64. This potentiometer provides an uncalibrated, continuous control of the deflection coefficients.

3.1.1.8. Delay line circuit

The delay line circuit consists of an assymmetrically driven differential amplifier (TS902 & TS903), which is coupled with emitter followers (TS901, TS904 & TS906) at the input as well at the output.
Emitter follower TS906 serves the symmetry. From resistor R903 in the emitter circuit of transistor TS901 the signal is, via the delay line, applied to the differential amplifier. The delayed test signal is coupled to the output stage via emitter follower TS904, which reduces the effect of the input capacitance of the output stage on the differential amplifier.
The input of the delay line is terminated by R903/R904 and its output by R907.
Transistor TS905 acts as a constant emitter-current source for amplifier stage TS902 - TS903.

3.1.1.9. Output amplifier

From the emitter of emitter follower TS904, the signal is applied to the base of transistor TS66 which is part of a differential amplifier. By varying the series feedback of this amplifier by means of potentiometer R111, the overall gain of the Y_A channel can be set. The RC combination R113-C62 corrects the gain factor at high frequencies.

The Y shift voltage derived from POSITION potentiometer R11 is applied to the base of transistor TS67.
If BEAM SELECTOR switch SK14 is not depressed, the voltage on the base of TS67 is such that the trace is shifted off the screen and cannot be brought back with the POSITION potentiometer.

From the differential amplifier the signal is fed to the final stage which consists of two single-ended push-pull sections, viz. TS57, 58, 59, 68 and TS69, 73, 74, 76. From these two sections, the signal is applied to the Y deflection plates.
The circuit with transistor TS56 will be discussed together with the c.r.t. circuitry (section 3.1.6.2.1.).
In position X via Y_a, the signal is fed to the X output amplifier via emitter follower TS75. In this case the channel Y_A output amplifier is inoperative.

3.1.2. CHANNEL Y_B VERTICAL AMPLIFIER

As this channel is identical to channel Y_A with the exception of the circuitry for external X deflection, the description of channel Y_A also holds good for channel Y_B. Components are assigned in the 200-299 range (corresponding to numbers in the 1-99 range for channel Y_A), in the 300-399 range (corresponding to range 100-199 in channel Y_A) and in the 1000-1099 range (corresponding to range 900-999 in channel Y_A).

3.1.3. TRIGGERING

The trigger unit comprises the following circuits:
a trigger pre-amplifier, a differential amplifier, trigger mode selector and a trigger-pulse shaper.
The circuit diagram shows all triggering push-buttons in their released positions.

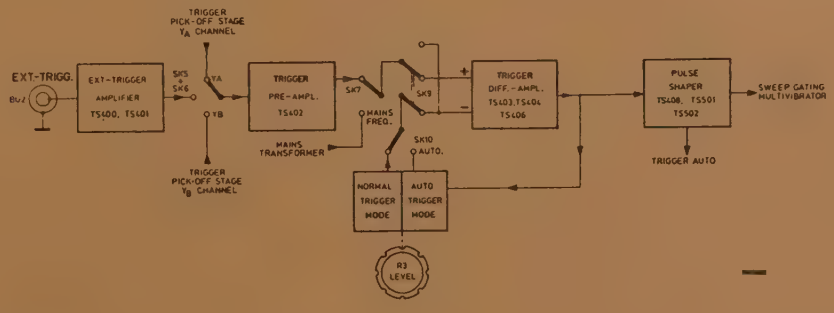


Fig. 3.3. Trigger unit

3.1.3.1. Trigger pre-amplifier for internal triggering

If Y_A push-button SK4 is depressed, trigger pick-off stage TS64 in the Y_A channel and transistor TS402 form together an amplifier with series and shunt feedback. Y_A push-button SK4 is only a mechanical release for Y_B push-button SK5 and is, therefore, not included in the circuit diagram; thus, SK4 depressed corresponds to SK5 released. The gain of trigger pre-amplifier is determined by the ratio of the shunt feedback resistance R412 and the series-feedback resistance in the emitter circuit of transistor TS64.

If Y_B push-button SK5 is depressed, trigger pick-off stage TS264 in the Y_B channel and transistor TS402 form the trigger pre-amplifier.

3.1.3.2. Trigger pre-amplifier for external triggering

If EXT. push-button SK6 is depressed, transistors TS401 and TS402 form together a similar amplifier with series- and shunt-feedback as described in section 3.1.3.1. Transistor 400 serves as an inverter for the triggering signals so that the next stage is driven in the correct phase. Moreover, this transistor improves the stability of the pre-amplifier. The external trigger input is protected against excessive positive input voltages by means of diodes GR401 and GR402.

3.1.3.3. Long-tailed pair circuit (differential amplifier)

The following description applies to internal triggering.
From the pre-amplifier the triggering signal is fed to the long-tailed pair circuit with transistors TS403 and TS404. The signal is applied to the base of transistor TS403 if + push-button SK8 is depressed and to the base of TS404 if – push-button SK9 is depressed.
This allows triggering on either the positive or negative slope of the signal. The + push-button SK8 is a mechanical release for – button SK9 and is, therefore, not included in the circuit diagram.

3.1.3.4. Trigger mode selector

A d.c. voltage which is variable with LEVEL potentiometer R3' is applied to the base of the non-driven transistor of the long-tailed pair circuit (3.1.3.3.).
As a long-tailed pair circuit amplifies the difference of the base voltages, the setting of potentiometer R3' determines which part of the signal will be amplified and, thus, the trigger level.
The output signal of the long-tailed pair circuit is fed to emitter follower TS406. If AUTO push-button SK10 is depressed, the a.c. component of the emitter signal of TS406 is applied to the full-wave rectifier with diodes GR404 and GR406. The rectified voltage across LEVEL potentiometer R3'' corresponds to the peak-to-peak value of the a.c. component of the trigger signal. This d.c. voltage is fed to the base of transistor TS404 of the long-tailed pair circuit. The result is that in the auto mode the trigger level range corresponds to the peak-to-peak value of the triggering signal.

3.1.3.5. Trigger-pulse shaper

The trigger-pulse shaper comprises transistors TS501 & TS502 in Schmitt-trigger configuration. With a repetitive trigger signal, a square-wave voltage of constant amplitude and width arises at the collector of TS502. This square-wave voltage is differentiated by C502 and R514 into narrow positive and negative pulses. The positive pulses are short-circuited by GR501 so that sweep-gating multivibrator TS503-TS504 receives only negative pulses.

3.1.4. TIME-BASE GENERATOR

The time-base generator comprises a sweep-gating multivibrator, a sawtooth generator, a hold-off circuit and an auto circuit.

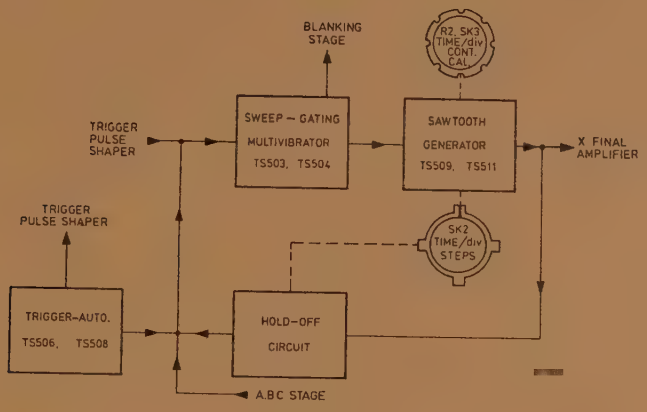


Fig. 3.4. Time-base generator

3.1.4.1. Sweep-gating multivibrator and sawtooth generator, single and erase functions

The sweep-gating multivibrator comprises transistors TS503 and TS504 in Schmitt-trigger configuration. In the state transistor TS503 cut off and transistor TS504 conducting, transistor TS509 is cut off. Then the time-base capacitor selected with TIME/div switch SK2 is charged with a constant current supplied by transistor TS511. The rate of voltage increases which determines the sweep time or time coefficient, is inversly proportional to the capacitance of the selected capacitor and direct proportional to the current through transistor TS511. This current is determined by the base voltage of transistor TS511, the voltage of which can be set by the TIME/div vernier control R2 and preset by potentiometers R534 and R539. The charging current is, moreover, determined by the value of the emitter resistors of transistor TS511, which are also switched over by TIME/div switch SK2.
The sawtooth voltage is taken off by a cascade circuit consisting of emitter followers TS512 and TS513 and applied to both the hold-off circuit and the horizontal amplifier.

Via the hold-off circuit, the sawtooth voltage is fed back to the input of the sweep-gating multivibrator whose input level is preset with stability potentiometer R553. At a certain value of the sawtooth voltage, in the automatic mode, the sweep-gating multivibrator is set to the state transistor TS503 conducting and transistor TS504 cut off. In the other trigger modes (except SINGLE mode) the switching over occurs when the sum of sawtooth voltage and trigger pulses reaches a certain value. Then transistor TS509 starts conducting and the time-base capacitor is discharged via this transistor. This cycle is repeated upon arrival of the next trigger pulse.

In the SINGLE mode a signal coming from flip-flop I.C. 1003 is fed to the input of the sweep-gating multivibrator via diode GR1026. The sum signal has such a level that incoming trigger pulses cannot switch over the multivibrator. Transistor TS503 is in the conducting state, transistor TS504 is cut off and transistor TS509 is conducting
By pressing the RESET button, the sum signal decreases to such a level that the first coming trigger pulse switches over the sweep-gating multivibrator and the sweep runs only once (see Fig. 3.12 Simplified circuit diagram).

If the ERASE button has been pressed a signal is fed to the sweep-gating multivibrator via diode GR1027. This signal comprises a d.c. component and a pulse of 0,6 sec. which ensures that the time-base does not start again before the time-base capacitors have been entirely discharged. Due to this signal the sweep-gating multivibrator will be set to the state transistor TS503 conducting, transistor TS504 cut-off and transistor TS509 is conducting. In this position the time-base capacitors are discharged, and the time-base will run again upon arrival of the next trigger pulse (see Fig. 3.12. Simplified circuit diagram).

3.1.4.2. Hold-off circuit

Due to the effect of diode GR504, the charge of the hold-off capacitor selected with TIME/cm switch SK2, cannot follow the decay of the sawtooth voltage.
The capacitor voltage will then decrease with an RC time which is sufficiently large to allow the sawtooth to reach its zero level and to ensure the decay of the switching phenomena. During this RC time, the input level of the sweep-gating multivibrator is so high that incoming trigger pulses have no effect.

3.1.4.3. Auto circuit

The AUTO circuit makes the time-base generator free-running when there are no trigger pulses.
The AUTO circuit works in every trigger mode, except when either AC push-button SK11 or DC push-button SK12 is depressed.

If there are trigger pulses, they are fed to the base of transistor TS506 of the AUTO circuit. As a result of this, the two transistors TS506 and TS508 of the AUTO circuit are conductive until capacitor C506 is discharged. The voltage at the cathode of diode GR502 is then so positive that the latter remains blocked and the working of the sawtooth generator, as described above, is not affected.

As soon as there are no trigger pulses, capacitor C506 will be charged and diode GR502 becomes conductive. The voltage level at the input of the sweep-gating multivibrator TS503-TS504 then drops to such a value that the multivibrator switches over and a sawtooth is formed. This occurs immediately after the drop of the hold-off pulse, i.e., the time-generator is free-running.

3.1.5. HORIZONTAL AMPLIFIER

In the time positions of TIME/div switch SK2 the sawtooth voltage of the time-base generator is fed to the base of transistor TS603. The sawtooth is also applied, for external purposes, to TB OUT socket BU6 via emitter follower TS516.

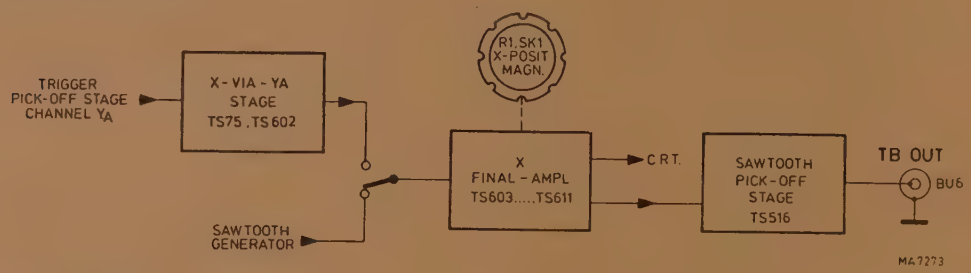


Fig. 3.5. Horizontal amplifier

In position X via Y_A of TIME/div switch SK2, the external X deflection voltage applied to the Y_A channel is fed from transistor TS64 to the base of transistor TS603, via emitter follower TS75 and amplifier TS602. The external X deflection voltage is also applied to TB OUT socket BU6, via emitter follower TS516.

The horizontal output amplifier comprises two stages.
The first one with transistors TS603 and TS604 is provided with series-feedback.
The second one consists of two single-ended push-pull sections TS607-608 and TS609-611 with shunt-feedback.
From the latter stage the deflection signal is fed to the c.r.t.

The gain of the output amplifier is determined by the shunt-feedback resistors R628 and R633, and the emitter resistance of transistors TS603 and TS604.
X MAGN switch SK1 allows a gain control in two steps.
If switch SK1 is closed (X MAGN knob pulled out), the series-feedback in the emitter circuit of transistors TS603 and TS604 is decreased in such a way that the gain of the output amplifier is increased by a factor of 5.
In the latter mode, the magnified mode, the gain can be preset by means of potentiometer R617 and in the normal mode by means of potentiometer R618.
In position X via Y_A of TIME/div switch SK2, switch SK1 is bypassed and the output amplifier works in the magnified mode.

The horizontal shift voltage coming from X POSITION potentiometer R1 is supplied to the base of transistor TS604. Transistor TS606 acts as a constant emitter-current source for amplifier stage TS603-TS604.

3.1.6. CATHODE-RAY TUBE CIRCUITRY

3.1.6.1. General information

The CRT circuitry provides the voltage levels, timing pulses and comprises control circuits necessary for storage operation of the cathode-ray tube.

This circuitry consists of the following sections:

- Control circuits for correction and adjusting of astigmatism, trace rotation, orthogonality, flood gun voltages, barrel and pin-cushion distortion and focus.
- Storage unit.
- Automatic brightness control unit.
- Blanking circuit.

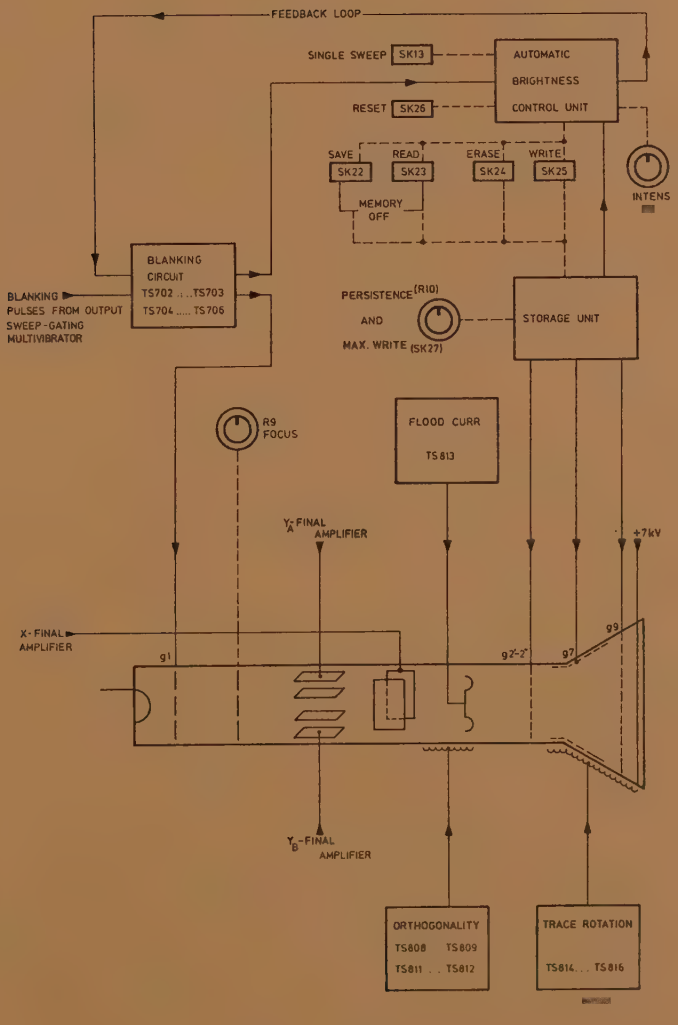


Fig. 3.6. Cathode-ray tube circuitry

3.1.6.2. Control circuits

. Astigmatism is corrected on a low-impedance level by means of potentiometer R809 via emitter follower TS801.

. Trace rotation is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan.
The degree and direction of rotation is determined by setting of potentiometer R813 on the bases of the complementary transistors TS814 and TS816.

. Orthogonality correction is also achieved by means of a coil, which is mounted inside the mu-metal screen. The magnetic field of this coil provides adjustment of the X/Y deflection angle to 90°. The current through this coil is controlled by two complementary pairs of emitter followers (TS808, TS809 and TS811, TS812), the base voltages of which are controlled by potentiometers R834 and R838.

. Flood gun cathode and grid (g1) voltages are controlled on a low-impedance level by emitter follower TS813. By means of potentiometer R847 the balance of both cathode voltages is adjustable. The flood current is controlled by the voltage levels on the grids "g1" and adjustable with potentiometers R848 and R849.

. Barrel and pin-cushion distortion is corrected with the aid of potentiometer R812.

. The display can be focussed by means of FOCUS potentiometer R9. In a spit-beam c.r.t. as used in this oscilloscope, focussing has certain consequences. These consequences and their remedies are discussed in section 3.1.6.2.1.

3.1.6.2.1. Focussing in the split-beam c.r.t.

In the split-beam c.r.t. the electron beam is split into two parts which form the traces of the Y_A and Y_B channel.
Both traces are controlled independently by the controls of both channels. The electron beam is focused, however, before it is split and, therefore, there is only one focus control. This mono-knob control of the focus has the following consequence.
Assume a focus setting as illustrated in Fig. 3.7.a.
Then the focusing point is exactly on the screen.
When the FOCUS potentiometer R9 is rotated, the focusing point is displaced to a point either side of the screen (Figs. 3.7.b. & 3.7.c.). This results in both traces moving away from each other. The more clockwise or anti-clockwise the FOCUS control is turned, the further the traces move apart.

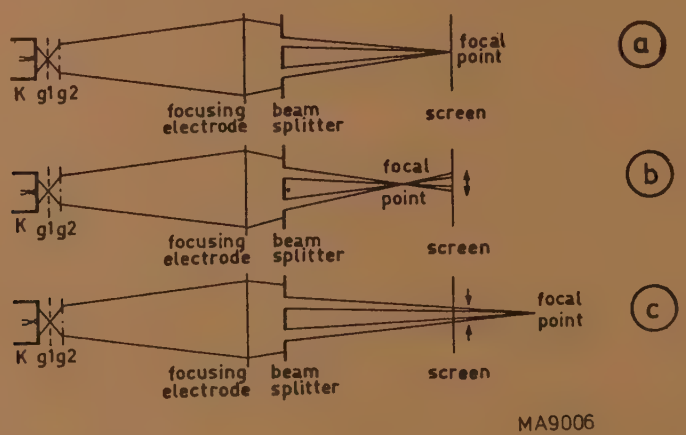


Fig. 3.7. Effect of the focus control

To compensate for this trace shift, an extra shift voltage is fed to the vertical amplifier channels via transistor TS56. The magnitude of this voltage is controlled by potentiometer R9' which is part of FOCUS tandem potentiometer R9. The control is such, that the displacement caused by operation of the FOCUS control is compensated for.
The compensation voltage for channel Y_A is obtained from the emitter of transistor TS56 and that for channel Y_B from the collector.
The compensation is so effective that the maximum displacement of each trace, caused by rotating FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise, does not exceed 2 mm.

3.1.6.3. Storage unit

3.1.6.3.1. General information

The storage circuit, located on the storage unit, supplies voltage levels and timing pulses to control the storage part of the C.R.T. in the SAVE, READ, ERASE and WRITE modes and in the positions PERSISTENCE and MAX. WRITE.
The storage circuit will be discussed with the aid of the simplified diagram of this circuit as shown in Fig. 3.12.
The schematic of this circuit is on the diagram Fig. 3.51. at the rear of the manual.

3.1.6.4. WRITE mode

The WRITE mode is operative after depressing push-button SK25.
Assume that as a result of an ERASE control signal the storage layer (g9) is at a potential below the cut-off level (Fig. 2.9. and 3.10.) and no flood-gun electrons reach the screen. We now activate the writing gun and let the electron beam move over the storage layer surface. Due to the high potential difference between the writing cathode and the storage mesh (approx. 1500 V), the electrons arrive at the storage layer with such an energy (velocity) that secundary emission occurs. Wherever the surface is struck by the electrons, a positive charge will arise. The highest potential that can be attained in this way is +32 V (see Fig. 3.9.) in relation to earth (approx. same potential as the flood gun cathode). At any value above this potential, the flood-gun electrons would be attracted by the storage-layer surface, thus reducing its potential to the original +32 V value. Those areas of the storage-layer surface that have been charged to near +32 V in relation to earth, allow the post-accelerator field to 'reach through' and capture flood-gun electrons.
Thus, the pattern of charge on the storage-layer surface is displayed on the screen.

In the WRITE mode, potentiometer PERSISTENCE may be used to vary display persistence from less than 0,3 sec to more than 1,5 min. This persistence control is attained by using a series of square-wave pulses (Fig. 3.10.) in order to periodically "wipe" the written signal from the storage layer.
These erasure pulses are obtained by comparing (I.C. 1001 4.5.13.) a 2 kHz triangular voltage with the variable d.c. voltage of PERSISTENCE potentiometer R10.
For explanation of the diagrams are 3.1.6.7. "Erasure in the write mode".

The potential of the flood-gun accelerators g'2 and g''2 depends on the selected operating mode (see Fig. 3.8. and oscillogram 19 in the circuit diagram). In the MEMORY OFF (SAVE and READ push-buttons operated simultaneously) and WRITE modes, transistor TS1019 is hard on and the potential of the flood-gun accelerators is continuously +80 V in relation to earth.

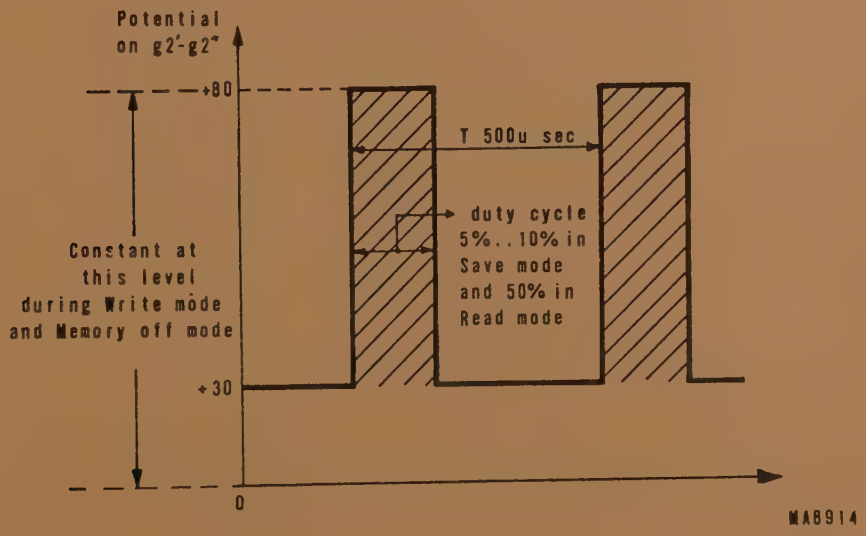


Fig. 3.8. Flood gun accelerators potential during storage mode

3.1.6.5. SAVE and READ modes

If either the SAVE push-button or the READ push-button is depressed, the flood-gun accelerators are supplied with a positively pulsed signal at different duty cycles (see Fig. 3.8.) which determines the display brightness. This pulse signal is obtained by comparing the 2 kHz triangular voltage with fixed (via R1064 and R1067) or variable (via R1068) d.c. voltages. When the READ push-button has been depressed, the duty cycle is 50 %. If push-button SAVE is depressed, the duty cycle is 5 to 10 % (value adjusted by means of preset potentiometer R1068). In this mode, as the duty cycle is low, the flood current will be minimum. Due to this, the brightness is low, and the storage time will be maximum.

3.1.6.6. ERASE function

The stored information can be erased in two different ways:
either manually or automatically. Automatic erasure is possible in the WRITE mode only, the duty cycle being dictated by the setting of the PERSISTENCE potentiometer.

Manual erasure

In the manual erasure mode the potential of the storage mesh (g9) is varied in accordance with the curve shown in Fig. 3.9.a.
The corresponding curve for the storage-layer surface potential is shown in Fig. 3.9.b.
If the ERASE push-button is operated during the period t0-t1, the potential of the storage mesh is equalised to that of the collector mesh (+180 V).

Owing to the capacitive coupling, the storage-layer surface potential rises to almost the same value. As Va is then +180 V in relation to earth, the storage-layer surface is bombarded with flood-electrons of much higher energy level than at first cross-over point (see Fig. 2.4.), which results in a large amount of secundary emission. Therefore, the surface potential becomes strongly positive (+180 V) and all information in the storage layer is overruled. The surface potential cannot increase much beyond +180 V because the collector mesh would then repel the emitted electrons back to the storage surface, tending to decrease its potential.

If the ERASE button is released at moment t1, the potential of the storage mesh drops to +32 V (due to the pulses produced by the circuits "time delay" and the logic circuit I.C. 1002) and the storage layer surface follows suit due to the capacitive coupling.
After 200 ms at moment t2, the storage mesh potential is automatically raised to +38 V in relation to earth. It is held at this value for 400 ms. The storage-layer surface is raised to the same potential due to the capacitive coupling, but then starts capturing flood-gun electrons and the potential decays again towards +32 V in relation to earth.

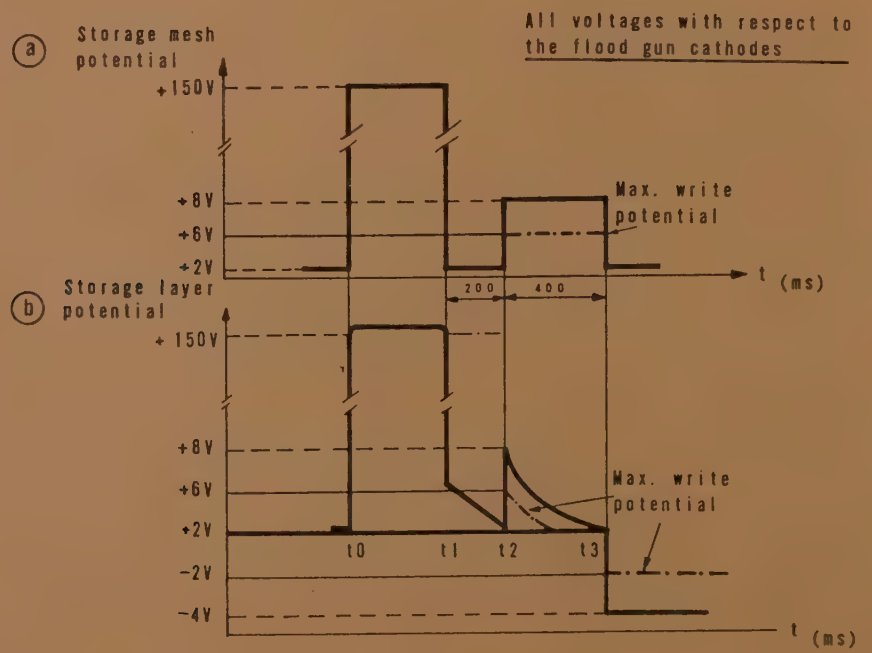


Fig. 3.9. a. Storage-mesh potential during erase cycle
b. Storage-layer surface potential during erase cycle

At the end of the 400 ms at moment t3, the storage mesh potential drops to +32 V. As a result, the potential of the storage-layer surface drops from +32 V to +26 V. The erasure cycle is then complete and the system is in waiting position. During the erasure cycle, there is fed via diode GR1027 a d.c. signal to the hold-off circuit to inhibit initiation of a sweep during erasure. After releasing push-button ERASE a delayed signal of 0,6 sec + 0,3 sec , extra delay via C1029 - R1110 (via the same diode) ensures the decay of the charge of the time base capacitors to zero level.

3.1.6.7. Erasure in the WRITE mode

In the WRITE mode, the potential of the storage-layer surface is gradually brought back to below the cut-off value by a number of automatic cycles of pulsed erasure (see Fig. 3.10.a.). The erasure signal is a square-wave voltage of approximately 2 kHz supplied by IC1001 and fed to storage mesh g9. This signal and the appertaining potential on the storage-layer surface are shown in Fig. 3.10. (b & c).

As in the manual erasure mode, the storage layer potential follows the voltage changes on the storage mesh. However, during each pulse the storage layer potential becomes positive in relation to the flood-gun electrons. Consequently, the potential drops by an amount of ΔV (see Fig. 3.10.b.). If this process is repeated a number of times, the rest potential on the storage-layer surface will eventually pass the cut-off level and the stored information will be erased. When the pulse width or, in other words, the duty cycle is increased, the drop in layer potential is increased too (ΔV' in Fig. 3.10.c.) and it takes less time (or pulses) to complete the erasure. The duty cycle of the erasure pulses can be varied between 0 and 30 % (corresponding to 0.3 seconds and 1.5 minutes) by means of PERSISTENCE potentiometer R10.

3.1.6.8. MAX. WRITE mode

The secundary emission of electrons from the storage-layer surface caused by the bombarding flood-gun electrodes must charge the layer from its erased potential of +26 V (all voltages in relation to earth) to the storage threshold (cut-off level) of approximately +29 V, before flood-gun electrons come under the influence of post accelerator g10 (see Fig. 3.9.&3.10.). Therefore, it is obvious that the writing speed of the c.r.t. can be enhanced by erasing the surface to just below the storage threshold, say to +28 V in stead of +26 V. If the instrument is switched to the MAX. WRITE mode, R1081 and R1083 are connected in parallel to R1082 and R1084. As a result of this, the amplitude of the erase pulse between moments t2 and t3 in Fig. 3.9.b. is approximately halved. Consequently, the potential of the storage-layer surface after erasure is approximately +28 V. As the layer potential is raised to almost the threshold potential, a larger part of the electron cloud will reach the phosphor viewing screen, resulting in a light-green background hue. Although the contrast is reduced a little, the writing speed for fast single shot signals is increased by a factor of 10.
In the MAX. WRITE mode, also the collimator voltage is adapted to the new circumstances by changing the current flow to the summation point of the OP-AMP. This results then in a lower collimator voltage. The erasure signal is always fed to the collimator in order to shake the electron cloud. In this way, an even hue is obtained.

The output quantity of the ΔV collimator device, the collimator voltage level device and the max. write device are combined in operational amplifier TS1014-TS1015. This operational amplifier is basically the adding circuit shown in figure 3.11.

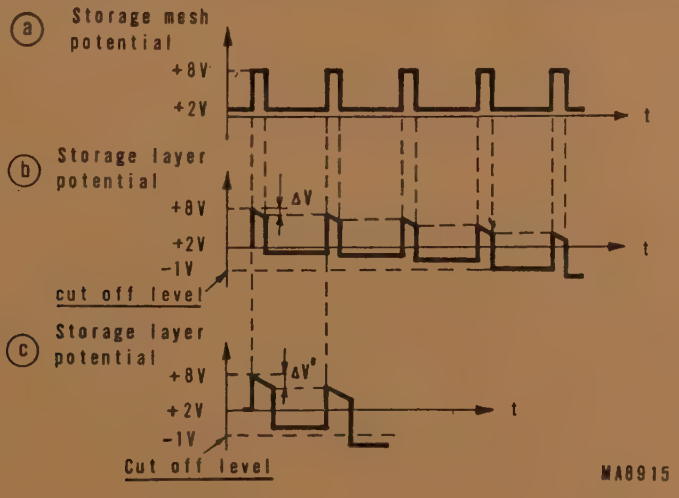


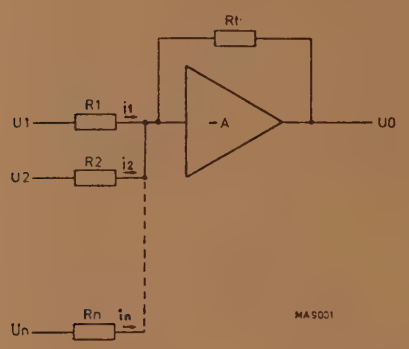
Fig. 3.10. a. Storage-mesh potential during variable persistence mode
b. Corresponding storage-layer surface potential containing information
c. Same as b. but persistence adjustment shorter (bigger pulse width)

3.1.6.9. Automatic brightness control unit

The A.B.C. unit is a circuit which controls the trace brilliance by means of the following devices.

- The ratio between sweep time and combination sweep time/hold-off time (in the following text this ratio will be called duty cycle). If this ratio drops to half, i.e. half the sweep time at the same combination time, the trace brilliance will double so as to give a constant brilliance impression on the screen.
- The INTENS potentiometer which operates on a low voltage level.
- During erasure, the beam must be suppressed. In the display mode y = f(t), the trace is blanked by a signal from the time-base generator. In the display mode y = f(x), blanking is provided by a special circuit.

The output quantities of the devices are combined in operational amplifier TS1029-TS1031. This operational amplifier is basically the adding circuit shown in Fig. 3.11.



Relation between input and output quantities in an adding circuit is:

$$U_o = R_t (i_1 + i_2 + \ldots\ldots i_n)$$

$$U_o = R_t \left(\frac{U_1}{R_1} + \frac{U_2}{R_2} + \ldots \frac{U_n}{R_n} \right)$$

Fig. 3.11. Operational amplifier

The output voltage of this operational amplifier is used as supply voltage for the Z amplifier (collector voltage of TS704).

Blanking circuit and duty cycle

The blanking circuit blanks the c.r.t. during the fly-back of the time-base generator and unblanks the c.r.t. during the sweep and constantly if TIME/cm switch SK2 occupies position X via Y_A.

The blanking circuit operates on a low voltage level and comprises an a.c. and a d.c. path.

Transistor TS706 is driven by the collector signal of transistor TS504 in the sweep-gating multivibrator. Transistor TS706 forms together with transistor TS704 a single-ended push-pull circuit. The gain factor of this amplifier is such that even when the collector voltage of TS704 is maximum, the Z signal is limited to this voltage. In other words, the amplitude of the Z signal is determined by the output voltage of operational amplifier TS1029-TS1031.

- A.C. PATH : The amplified a.c. components of the blanking signal are fed direct to the Wehnelt cylinder of the c.r.t. via H.T. capacitor C707.
- D.C. PATH : For the d.c. component of the blanking signal, the signal of oscillator TS702-TS703 is used. The oscillator signal is modulated with the blanking signal. The amplified modulated signal on the collector of transistor TS703 is via capacitor C706 fed to demodulator GR702-R713. After demodulation, also the d.c. component of the blanking signal is available.

The a.c. and d.c. amplifications are equalized by means of potentiometer R711.
The Z signal (diagram 11 of Fig. 3.51) is fed via a divider/integrator circuit to the emitter follower TS1028. Via emitter follower TS1028, this signal is applied to input of operational amplifier TS1029-TS1031. In this way, a closed loop is obtained. The other output quantities of the a.b.c. unit are also used as input signals for this loop. In the loop, the mean value of the Z signal is fed back to the blanking stage with transistors TS702, 703, 704 and 706. If the loop gain were very large, the mean value would be constant owing to the feedback. A constant mean value means: half the amplitude when the pulse width is doubled.

The loop gain, however, is low (≈ 4) and, therefore, the duty cycle is not inversely proportional to the amplitude of the Z signal. The relationship between the Z signal on the Wehnelt cylinder and the beam current (intensity) to the screen of the c.r.t. is not linear either, because of the curved c.r.t. characteristic. Both types of non-ideal behaviour together result, however, in an inversely proportional relationship between beam current and duty cycle.

In the lower sweep speed positions of the time-base generator, the period time of the Z signal is long. To be able to integrate these signals well the time constant of the integrator must be large, i.e. several seconds. There is also the requirement that the system must be able to react fairly quickly: well within one second, in the faster sweep speed positions. Both requirements are incompatible. Therefore, a small time constant is used in this oscilloscope, whereas in the slower sweep-speed positions (20 mS - 0,5 S) capacitor C1027 is interrupted. As a result of this the output of the blanking stage will not be integrated in these slower sweep-speed positions.

Blanking and unblanking in WRITE, READ, SAVE and MEMORY-OFF mode

The four functions WRITE, READ, SAVE and MEMORY-OFF are selected by means of switches SK22, SK23 and SK25. The Z signal must only be present in positions MEMORY-OFF and WRITE. In the two latter positions a switch in series with resistor R1116 is interrupted. The current flowing through R1116 to the summation point then becomes zero. As a result of this, output voltage U_o of operational amplifier TS1029-TS1031 is able to raise and the Z signal is not zero any longer.

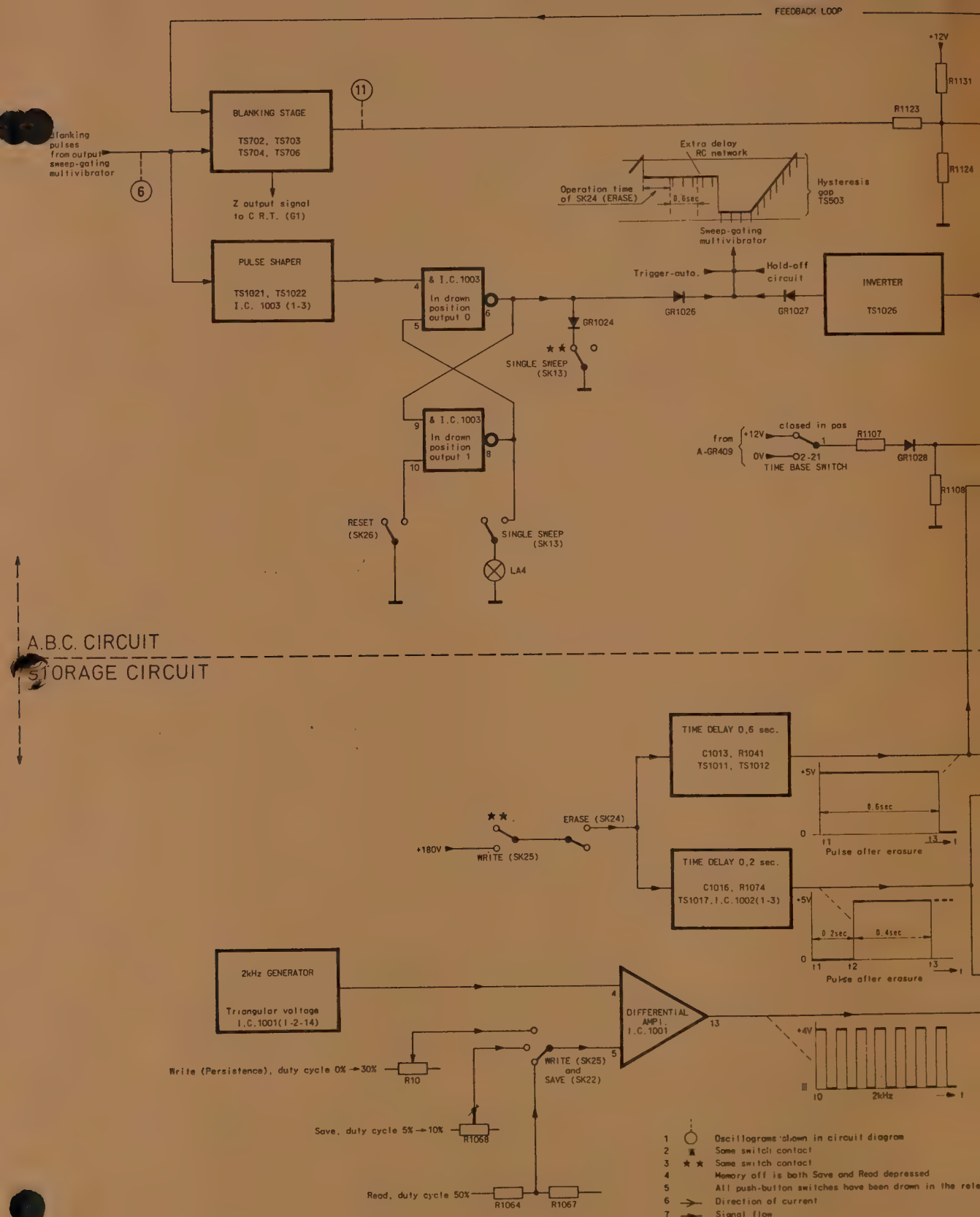
Blanking in the erase mode

In position X via Y_A of switch SK2, the y = f(x) mode, a logic '1' is applied to input 12 of NAND IC1003, via R1107 and GR1028. If at the same time a logic '1' is applied to the other input, point 13 of IC1003, via ERASE switch SK24, the logic output on 11-IC1003 will be '0'. Then R1114 is connected to +20 V and a current flows to the summation point of operational amplifier TS1029-TS1031. The output voltage U_o of the operational amplifier then drops to such a value that the Z signal becomes zero.

In the other positions of SK2, one of the inputs of IC1003 is always logic '0' regardless the level on the other input. The output on point 11 is then always '1', switch TS1023 is opened and no current flows through resistor R1114.

Intens potentiometer

The magnitude of the Z signal may be varied by changing the current to the input of operational amplifier TS1029-TS1031. Continuous control of the brightness is obtained by varying the current through R1137 with the aid of potentiometer R8. With preset potentiometer R1138, the maximum brightness is set.


FEEDBACK LOOP
+12V
R1131
R1123
R1124
BLANKING STAGE
TS702, TS703
TS704, TS706
11
Blanking pulses from output sweep-gating multivibrator
6
Z output signal to C R.T. (G1)
Extra delay RC network
Operation time of SK24 (ERASE)
0.6sec
Hysteresis gap TS503
Sweep-gating multivibrator
PULSE SHAPER
TS1021, TS1022
I.C. 1003 (1-3)
& I.C.1003
In drawn position output 0
Trigger-auto.
Hold-off circuit
INVERTER
TS1026
GR1026
GR1027
GR1024
SINGLE SWEEP (SK13)
& I.C.1003
In drawn position output 1
from A-GR409
+12V
0V
closed in pos 2-21
TIME BASE SWITCH
R1107
GR1028
R1108
RESET (SK26)
SINGLE SWEEP (SK13)
LA4
A.B.C. CIRCUIT
STORAGE CIRCUIT
TIME DELAY 0,6 sec.
C1013, R1041
TS1011, TS1012
+5V
0.6sec
Pulse after erasure
ERASE (SK24)
+180V
WRITE (SK25)
TIME DELAY 0,2 sec.
C1016, R1074
TS1017, I.C.1002(1-3)
0.2sec
0.4sec
2kHz GENERATOR
Triangular voltage
I.C.1001(1-2-14)
DIFFERENTIAL AMPl
I.C.1001
+4V
2kHz
Write (Persistence), duty cycle 0% → 30%
R10
WRITE (SK25) and SAVE (SK22)
Save, duty cycle 5% → 10%
R1068
Read, duty cycle 50%
R1064
R1067
1 Oscillograms shown in circuit diagram
2 Same switch contact
3 Same switch contact
4 Memory off is both Save and Read depressed
5 All push-button switches have been drawn in the rele
6 Direction of current
7 Signal flow

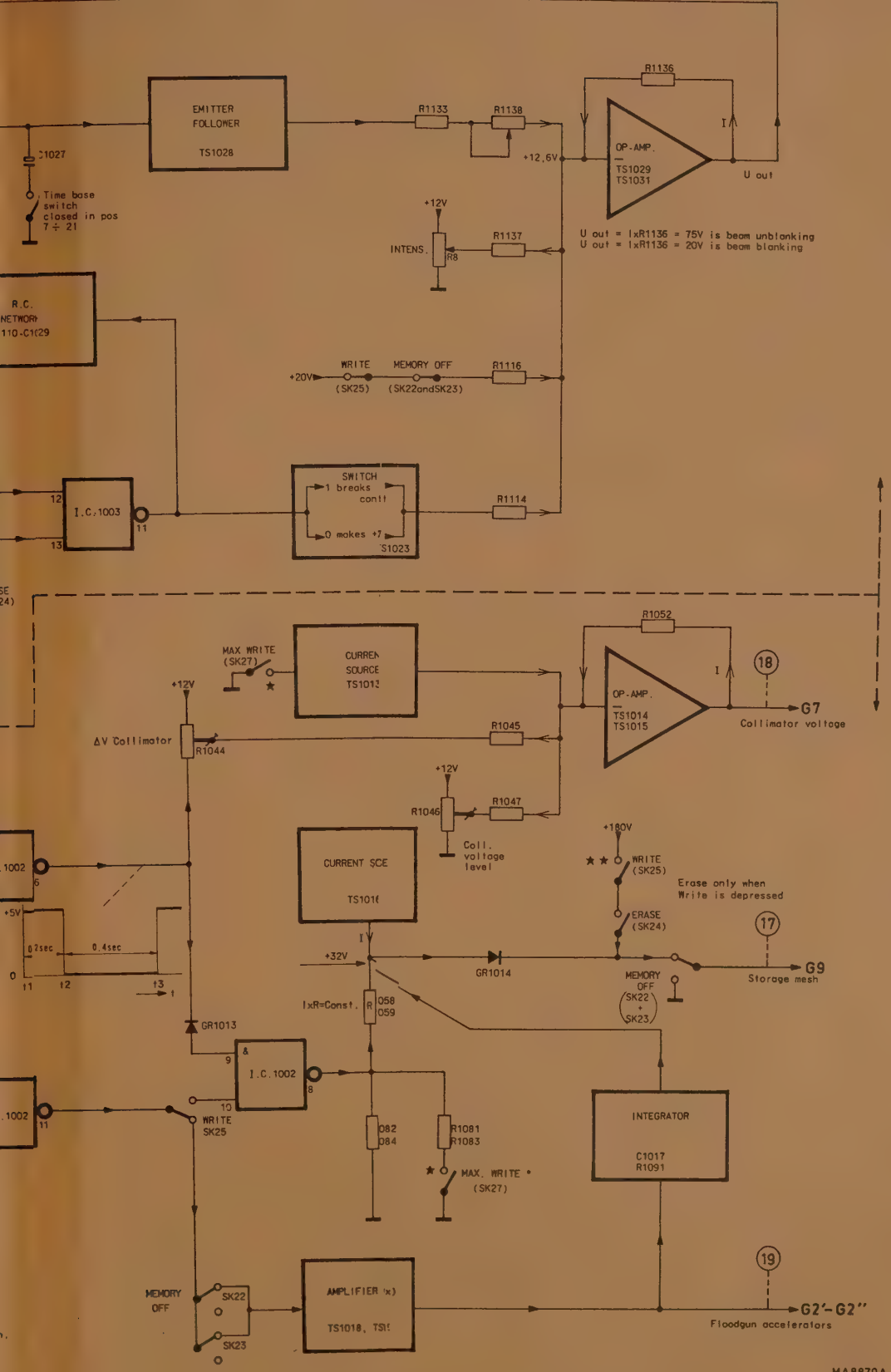


Fig. 12. Simplified circuit diagram of ABC stage and storage unit

3.1.7. POWER SUPPLY

The power supply comprises the mains transformer, a full-wave rectifier, stabilized power supply and converter.

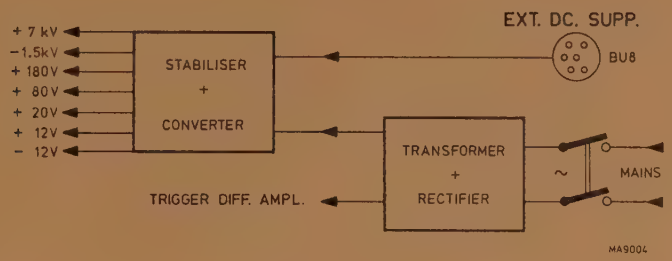


Fig. 3.13. Power supply

3.1.7.1. Mains transformer

Mains transformer TS801 has three primary windings (S1, S1' and S1'') which, together with the secondary winding (S2), can be combined by means of voltage adapter SK21. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

The voltage on secondary winding is full-wave rectified. The resulting negative d.c. voltage, or alternatively a negative d.c. voltage on EXT DC SUPPLY input socket BU8, is applied to the voltage stabilizer and converter.

Part of the a.c. voltage on secondary winding of the mains transformer is fed to MAINS trigger source switch SK7, to enable internal triggering on the mains frequency.

3.1.7.2. Converter and stabilized power supply

The converter is a regenerative square-wave generator operating at a frequency of approx. 18 kHz.
A basic diagram of the converter is shown in Fig. 3.14.

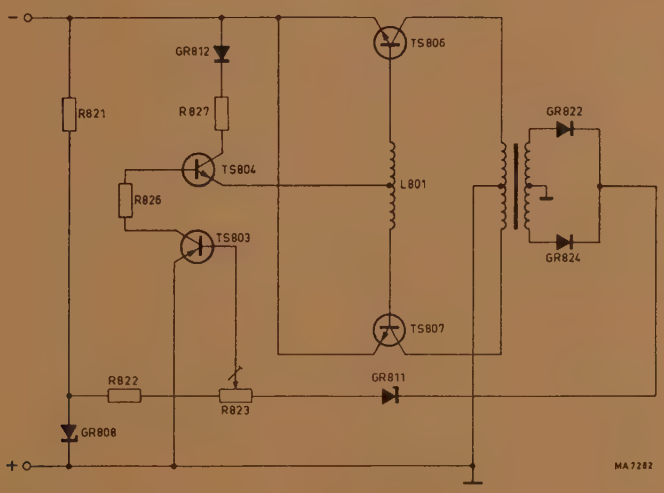


Fig. 3.14. Basic diagram of the converter

In the converter, transistors TS806 and TS807 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of L801/802. Assume that transistor TS806 has a slightly higher current gain than TS807. Then the positive voltage from the feedback winding quickly drives transistor TS806 into saturation. The current in the top half of the primary of L801/802 increases linearly at a rate determined by the inductance in the primary. This current increase continues until the iron in transformer coil L801 is saturated.
Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feedback winding. When its base drive ceases, transistor is cut off. This reverses the polarity of the feedback voltage and transistor TS807 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction. The subsequent absence of feedback voltage initiates the switching back to TS806 and the cycle starts again.

The regulation works as follows. When an input voltage is applied to the converter, the negative voltage across Zener diode GR808 turns transistor TS803 fully on, as there is no positive voltage from Zener diode GR811.

Then a bias current starts flowing from earth via transistor TS803 through resistor R826, through the base-emitter junction of transistor TS804 (operating as a diode since diode GR812 interrupts the collector circuit) and from base to emitter of both transistors TS806 and TS807.
As there is then an a.c. voltage across the secondary of L801/802, diodes GR822 and GR824 produce a positive d.c. voltage. This voltage reduces the current through transistors TS803 and TS804 sufficiently to limit the drive to transistors TS806 and TS807 and produce the desired output level. The setting of potentiometer R823 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via Zener diode GR811 to transistor TS803 so that the drive of transistors TS806 and TS807 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.

After rectifying the secondary voltages +12 V (reference), −12 V, +20 V, +80 V, +180 V, −1500 V and high voltage +7000 V are obtained. The voltage quadrupler which supplies the +7000 V cannot be repaired and must be replaced when it breaks down.

All supply voltage except the +7000 V and the −1500 V can be continuously short-circuited without damage to the components. Resistor R827 limits the maximum base current drive to transistors TS806 and TS807 and thus the maximum power output which can be drawn from the converter.
Resistor R826 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors TS806 and TS807 at a safe level. Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp failing to light up.

3.1.8. CALIBRATION VOLTAGE

The calibration voltage generator consists of free-running multivibrator TS750 & TS751. The generator frequency is approximately 2 kHz. The amplitude of the generated square-wave voltage is kept at a constant value by means of zener diode GR751. The exact value of the calibration is set with the aid of potentiometer R761.

3.2. Checking and adjusting

3.2.1. GENERAL INFORMATION

All adjusting elements have been listed in the heading of the various sections.
The tolerances mentioned in the following text apply to newly adjusted instruments only. The values may differ from those given in chapter 1.2. CHARACTERISTICS.
Unless otherwise stated the controls always occupy the same position as the previous check.

3.2.2. POWER SUPPLY

3.2.2.1. Mains current

- Check that the mains voltage adapter (SK21) has been set to 220 V and connect the instrument to such a voltage (frequency 50 Hz)
- Switch the oscilloscope on and check that the pilot lamp lights up
- Check that the current-consumption does not exceed 300 mA (measured with a moving-iron meter)

3.2.2.2. Supply voltages (R823)

- Check that the voltage across capacitor C833 is +12 V, + or −20 mV; if necessary, readjust potentiometer R823 (Fig. 3.15.).
- Check the supply voltages in accordance with the following table:

Voltage across	Required value	Max. allowable ripple
C833 (Fig. 3.15)	+ 12 V, ± 30 mV	4 mV_{p-p}
C836 (Fig. 3.15)	− 12 V, ±400 mV	6 mV_{p-p}
C831 (Fig. 3.15)	+ 20 V, ±900 mV	40 mV_{p-p}
C829 (Fig. 3.15)	+ 80 V, ± 2 V	250 mV_{p-p}
C828 (Fig. 3.15)	+180 V, ± 3 V	100 mV_{p-p}

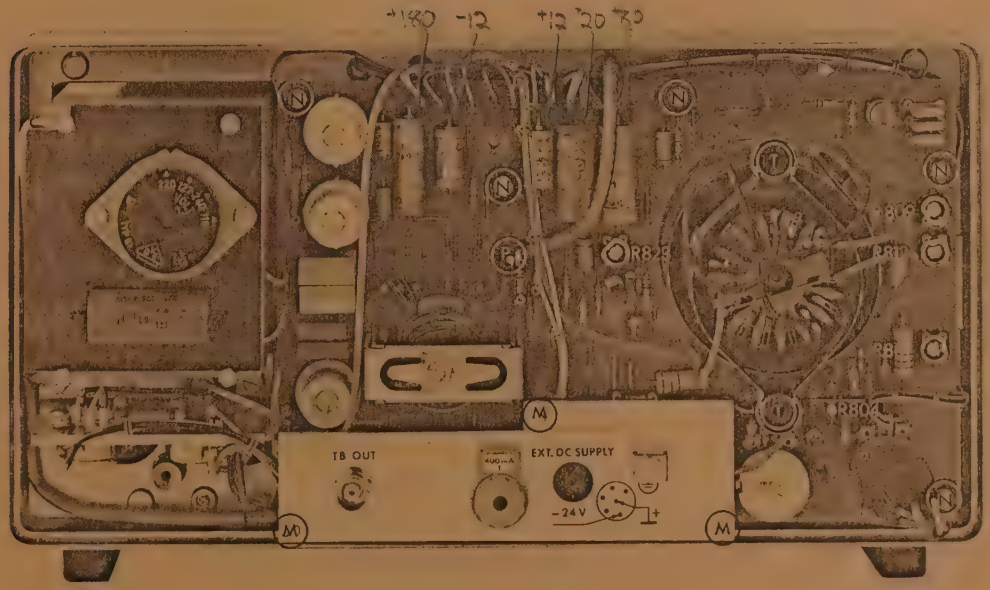


Fig. 3.15. Adjusting and dismantling

- Vary the a.c. voltage to which the instrument is connected between 198 V and 242 V.
- Check that the supply voltages do not vary more than 0.5 % and that the ripple voltages do not exceed the values mentioned in the table above.

3.2.3. CATHODE-RAY- TUBE CIRCUIT

3.2.3.1. Adjustment to display time-base lines

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display. Extended high intensity may damage the C.R.T.

3.2.3.1.1. Intensity (R801) and time-base stability (R553)

– Turn INTENS potentiometer R8 anti-clockwise.

1500 V: Use an insulated screw-driver

– Set potentiometer R801 (Fig. 3.15.) to its mid-position and potentiometer R553 (Fig. 3.17.) anti-clockwise.
– Depress buttons SAVE SK22 and READ SK23 simultaneously.
– Set X POSITION potentiometer R1 to its mid-position and depress MAGN switch SK1.
– Set the POSITION potentiometers R11 and R12 to their mid-positions.
– Set TIME/div switch SK2 to 1 ms.
– Depress BEAM SELECTOR switches A SK14 and B SK15.
– Set AMPL switch SK17 and SK18 to .2 V/div.
– Turn INTENS potentiometer R8 for a well-defined display, there should be a display of two time-base lines.
– If both traces are not equally bright, see point 3.2.3.2. "Beam correction".
– See for adjusting with component R801 point 3.2.3.6.

3.2.3.1.2. Time-base stability (R553)

– Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
– Turn potentiometer R553 (Fig. 3.17.) clockwise until the time-base line disappears.
– Depress AUTO switch SK10. A time-base line must become visible. If necessary, readjust potentiometer R553.

3.2.3.2. Beam correction (with the magnets)

– Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
– Set TIME/div. switch SK2 to 1 mS.
– Position the traces symmetrically around the centre of the screen using POSITION potentiometers R11 and R12.
– Set AMPL switch SK17 and SK18 to 0,2 V/div.
– Adjust INTENS potentiometer R8 for a low brightness.
– Check that both traces are equally bright. If necessary, turn screw T (Fig. 2.1) until both traces have the same brightness.

3.2.3.3. Focus and astigmatism (R809, R804)

– Set the TIME/div. switch to position X via Y_A.
– Position the spot to the centre of the screen using potentiometers X POSITION R1 and Y POSITION R12.
– Set INTENS potentiometer R8 for a just visible spot.

Use an insulated screw-driver

– Adjust FOCUS potentiometer R9 and astigmatism potentiometer R809 (Fig. 3.15.) for a sharp, well-defined spot.
– Set FOCUS potentiometer R9 in mid-stroke position and check for a sharp spot. If necessary select a different value for R804 (Fig. 3.15.).

3.2.3.4. Trace rotation and orthogonality (R813, R834, R838)

- Depress WRITE button SK25.
- Turn the PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Depress BEAM SELECTOR switch B SK15.
- Set INTENS potentiometer R8 for a low brightness.
- Push ERASE button SK24.
- Set TIME/div switch SK2 to X via Y_a.
- Set AMPL switches SK17 and SK18 to .2 V/div and AMPL potentiometer R4 and R5 to CAL.
- Apply a sine-wave signal of 1 kHz with amplitude of 4 V to inputs Y_A (BU3) and Y_B (BU5).
- Set AC-0-DC switch SK16 to AC.
- Set AC-0-DC switch SK19 to 0.
- Centre the time-base line by means of POSITION potentiometer R12.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust trace rotation potentiometer R813 (Fig. 3.16.).
- Set AC-0-DC switch SK16 to 0.
- Set AC-0-DC switch SK19 to AC.
- Centre the displayed line by means of X-POSITION potentiometer R1.
- Check that the displayed line runs exactly in parallel with the vertical lines of the graticule. If necessary, readjust orthogonality potentiometer R834 or R838 (Fig. 3.16.).

3.2.3.5. Barrel & pin cushion distortion (R812)

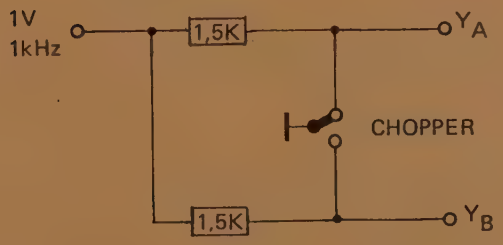
- Shift with the aid of X-POSITION potentiometer R1 the displayed vertical line (see point 3.2.3.4.) to the left- and right-hand side of the screen.

Use an insulated screw-driver. Be careful not to make any short-circuits.

- Check that the displayed line is straight and vertical in both positions.
  A small deviation may occur. If necessary, adjust and determine an average setting with the aid of potentiometer R812 (Fig. 3.15.).
- For optimum adjustment, repeat both checks 3.2.3.4. and 3.2.3.5.
- Set TIME/div switch SK2 to 2 μs/div.
- Shift with POSITION potentiometer R11 the displayed horizontal line to the upper and lower side of the screen.
- Check that the displayed line is straight; adjustable with potentiometer R812.
  If this adjustment was necessary, repeat both procedures 3.2.3.4. and 3.2.3.5.

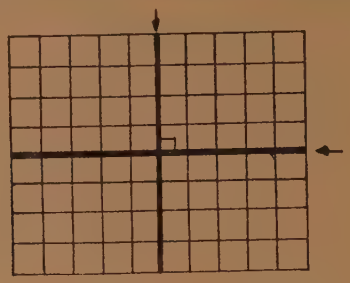
Trace rotation, orthogonality and Barrel & pin cushion distortion can also be adjusted in a different way:

- MEMORY OFF mode
- Channels A and B
- TIME/DIV to X via Y_A
- VOLT/DIV at 50 mV
- AC/0/DC to DC

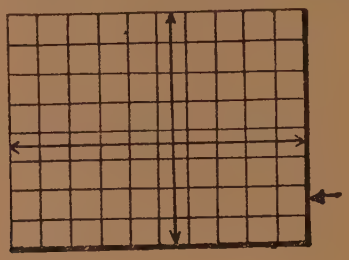


- Connect a channel-switch (see figure) to the input sockets.

– Centre both traces (using X-POSITION and Y-POSITION)
– Potmeter R838 to mid-range
– Align displayed lines with central vertical and horizontal graticule lines, using potmeters R813 and R834.



– Align the displayed lines with the outer graticule lines, using the X and Y POSITION potmeters.
– Straighten the displayed lines, using potmeters R812 and R813.



3.2.3.6. Brightness (R801, R711 and R1138)

<u>1500 V: Use an insulated screw-driver</u>

– Depress BEAM SELECTOR switches SK14 and SK15.
– Switch the instrument on at least 15 minutes before starting the next check.
– Set TIME/div. switch SK2 to X via Y_A.
– Set the INTENS potentiometer R8 to 90° from anti-clockwise stop

– Adjust potentiometer R801 (Fig. 3.15) for a barely visible spot (or just no display).
– Set TIME/div. switch SK2 to 10 mS/div.
– Set the INTENS potentiometer R8 to normal brightness.
– Shift the time-base lines on to the centre of the screen with the aid of POSITION potentiometers R11 and R12.
– Check that the time-base line shows a constant brightness over the entire length; if necessary, readjust potentiometer R711 (Fig. 3.17).
– Switch the instrument off, disconnect the flood gun Stocko connector and discharge G10.
– Depress both the SAVE (SK22) and READ (SK23) buttons (MEMORY OFF MODE).
– Set TIME/div. switch SK2 to X via Y_A and center the spot to the centre of the screen.
– Insert a μA meter, which is floating and good insulated, between G10 and the high tension unit (Fig. 3.19).
– Note the dark current: X μA.
– Set the INTENS potentiometer R8 fully clockwise.
– Adjust potentiometer R1138 (Fig. 3.17.) for a meter reading of 0,5 μA + X μA.
– Check that the meter reading lies between 0,8 and 1,2 μA in TIME/div. positions 0,5 S/div. to 0,2 μS/div. incl.
– **Switch the instrument off**, remove the μA meter, connect the floodgun Stocko connector and switch the instrument on again.

3.2.3.7. Focus correction

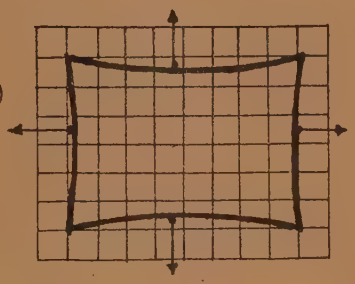
- Set TIME/div. switch SK2 to 0,5 mS/div.
- Depress buttons SAVE SK22 and READ SK23 simultaneously.
- Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
- Set AC-0-DC switches SK16 and SK19 to 0.
- Set the INTENS potentiometer R8 to low brightness.
- Set AMPL switches SK17 and SK18 to .5 V/div and AMPL potentiometers R4 and R5 to CAL.
- Shift the time-base lines on to the horizontal central graticule line with the aid of POSITION potentiometers R11 and R12.
- Rotate FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise and check that this does not cause the time-base lines to shift more than 0,2 div.

3.2.3.8. Flood-current (R844, R846, R847, R848, R849)

- Switch the instrument on at least 15 minutes before starting this check.
- Depress WRITE switch SK25.
- Set INTENS potentiometer R8 for minimum brightness.
- Set R847 (Fig. 3.19.) to its mid-position.
- Connect (floating) a DC mV-meter across R846 and adjust R848 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.
- Connect the mV-meter across R844 and adjust R849 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.

3.2.3.9. Backing-electrode G9 (R1059)

- Depress WRITE switch SK25.
- Adjust potentiometer INTENS R8 for minimum brightness.
- Rotate potentiometer PERSISTENCE R10 to its first clockwise stop.
- Connect a DC voltmeter Between G9 (+) and cathode K' (–). (Fig. 3.19.)
- Adjust R1059 (Fig. 3.19.) to obtain a 2 V (±100 mV) reading on the meter.



3.2.3.10. Collimator G7 (R1046)

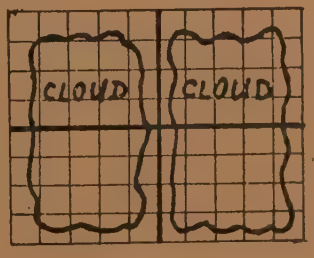
- Turn R10 PERSISTENCE entirely counter-clockwise.
- Push SK25 WRITE.
- Adjust R1046 (Fig. 3.19.) until the contour-distortions are just outside the measuring graticule.

3.2.3.11. Background just black (R847, R1044, R1084)

- Rotate potentiometer PERSISTENCE R10 to its first clockwise stop (not the MAX. WRITE mode)
- Turn potentiometer R1044 (Fig. 3.19.) to mid-range.
- Carry out the following adjustments on repetitive operation of the ERASE button SK24.
- Adjust R1084 (Fig. 3.19.) to obtain two barely visible clouds on the screen.
- Adjust R847 (Fig. 3.19.) for equal intensity of the clouds.
- Adjust R1084 (Fig. 3.19.) so, that the background of the screen is just black.

Max. Write (R1044, R1049 and R1083)

- Carry out the following adjustments on repetitive operation of the ERASE button SK24.
- Turn potentiometer PERSISTENCE R10 to its second clockwise stop (MAX. WRITE position).
- Set the potentiometers R1044 (Fig. 3.19.) and R1049 (Fig. 3.19.) to mid-range.
- Set potentiometer R1083 (Fig. 3.19.) entirely counter-clockwise.
- Two too bright clouds appear on the screen.
- Adjust potentiometer R1083 (Fig. 3.19.) for a uniform cloud distribution on the screen; to obtain sufficient contrast for the display, the background should not be too bright. If necessary, equalize the brightness of both clouds, using potentiometer R847 (Fig. 3.19.).
- Adjust potentiometer R1044 (fig. 3.19.) in such a way that both clouds reach as much screen surface as possible and obtain equal cloud distribution.



- Repeat above procedure, for optimum results, combined, if necessary, with writing-speed check dealt with in point 3.2.3.14.

3.2.3.12. Save (R1068)

- Depress SAVE switch SK22.
- The intensity of a saved signal is adjustable with R1068 (Fig. 3.19.).
- The normal position of R1068 is such that the square-wave voltage at G2' and G2'' shows 10 % duty cycle (±10 %).

3.2.3.13. Whistle (R1031)

- Turn potentiometer PERSISTENCE entirely anti-clockwise.
- It may happen that the meshes inside the CRT come into resonance with the square-wave voltages applied to them (about 2 kHz). This can be tuned out by a slight readjustment of R1031 (Fig. 3.19.).

3.2.3.14. Writing speed (writing and calculation)

Definition: The writing speed is the maximum speed of the electron in X- or Y-direction on the screen in single-shot mode at which the written line is visible.
The lines of the pictures obtained must be clearly visible in the WRITE mode as well as in MAX. WRITE mode.
Some divisions at the edge of the screen may be partly written or not at all (the written surface of the screen must be as symmetrical as possible).
The number of non-written divisions may not be more than 16 namely 20 % of the total 8x10=80 divisions of the measuring graticule.

Note: Before this check, the sensitivity of the vertical amplifiers must be adjusted (see point 3.2.4.5. SENSITIVITY).

- Set TIME/div switch SK2 to 2 ms/div and potentiometer TIME/div R2 to CAL.
- Turn INTENS potentiometer R8 entirely clockwise.
- Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Depress AUTO switch SK10.
- Depress WRITE switch SK25.
- Set AMPL switches SK17 and SK18 to 50 mV/div and AMPL potentiometers R4 and R5 to CAL.
- Apply a sine-wave signal of 1,6 $V_{p\text{-}p}$, 1 kHz, to Y_A input socket BU3 (a picture height of 32 divisions should be obtained).
- Set the POSITION potentiometers R11 and R12 to their mid-positions.
- Set AC-0-DC switches SK16 and SK19 to AC.
- Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
- Depress SINGLE switch SK13.
- Turn potentiometer PERSISTENCE R10 to its first clockwise stop.
- Push ERASE button SK24 shortly.
- Push RESET button SK26.
- The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.
- Apply the input voltage from the Y_A input socket BU3 to Y_B socket BU5.
- Depress Y_B switch SK5.
- Depress BEAM SELECTOR switch SK15, BEAM SELECTOR switch SK14 in released position.
- Push ERASE button SK24 shortly.
- Push RESET button SK26.
- The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.

– For both channels the focus has been adjusted for a maximum, and thus the maximum writing speed.
– Push ERASE button SK24 shortly.
– Push RESET button SK26.
– Check with the aid of a viewing hood that the display covers over 80 % of the measuring graticule.

For checking in MAX. WRITE mode the operation is the same but:
– Turn potentiometer PERSISTENCE R10 to its second clockwise stop.
– Frequency of the input signal 10 kHz.
– Set TIME/div switch SK2 to .2 ms/div.

Calculation: The vertical deflection is 32 divisions as mentioned above.
The path described by the electron beam is then 16 div. $\sin\omega t$ (ω being the circle frequency of the input signal).
The speed of the beam in the vertical direction is thus 16 $\omega\cos\omega t$ (the speed in horizontal direction is negligible).
For the visible part of the sine wave, $\cos\omega t = 1$ may be assumed.
The wiring speed is now (in Norm. writing mode):
$16.2\,\pi \,.\, 10^3$ div./s = 100 div./ms.

3.2.4. VERTICAL AMPLIFIERS

3.2.4.1. General information

– The adjustments of the vertical amplifier channels Y_A and Y_B are identical. The knobs, sockets and adjusting elements of channel Y_B are shown in brackets after those of channel Y_A.
– Unless otherwise stated the controls always occupy the same position as in the previous check.
– Adjust INTENS control R8 for adequate display brightness.

3.2.4.2. D.C. Balance (R6, R7)

– Depress WRITE switch SK25.
– Rotate potentiometer PERSISTENCE R10 entirely anti-clockwise.
– Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
– Set AC-0-DC switch SK16 (SK19) to 0.
– Set AMPL potentiometer R4 (R5) to CAL.
– Check that the trace does not shift if AMPL switch SK17 (SK18) is switched from .1 V/div to 2 mV/div. If necessary, readjust DC BAL R6 (R7). During the adjustment, the trace must be kept in the centre of the screen by means of POSITION potentiometer R11 (R12).
– Check that the position of the trace is the same in positions 2, 5, 10, 50 and 100 mV/cm of AMPL switch SK17 (SK18); the maximum allowable difference 0.2 div.

3.2.4.3. Gate current (R126, R326)

– Depress Y_A (Y_B) switch SK4 (SK5), BEAM SELECTOR switch A SK14 (B SK15) and + switch SK8.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Check that the trace does not jump when AC-0-DC switch SK16 (SK19) is switched from 0 to DC; if necessary, readjust potentiometer R126 (R326); Fig. 3.19. tolerance at final check 0.4 div.

3.2.4.4. Pre-amplifier (R64, R99, R264, R299)

– Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
– Set TIME/div switch SK2 to 10 ms and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 (SK19) to DC.
– Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
– Apply a square-wave voltage of 600 $mV_{p\text{-}p}$, 100 Hz, to Y_A (Y_B) input socket BU3 (BU5).
– Check that the pulse top is straight; if necessary, readjust potentiometer R99 (R299), Fig. 3.18.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Decrease the input voltage to 12 $mV_{p\text{-}p}$.
– Check that the pulse top is straight; if necessary, readjust potentiometer R64 (R264), Fig. 3.19.
– Check that in the ranges 50, 20, 10 and 5 mV/div of AMPL switch SK17 (SK18) the top is straight; tolerance 1 %.

3.2.4.5. Sensitivity (R111, R311)

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to 2 ms and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 (SK19) to DC.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Apply a voltage of exactly 600 mV_{p-p}, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the trace height is exactly 6 div; if necessary, readjust potentiometer R111 (R311), Fig. 3.18.
- Check that the control range of AMPL potentiometer R4 (R5) is 1:2,6 to 1:4.

3.2.4.6. Input attenuator (C28, C29, C33, C34, C52, C228, C229, C233, C234, C235, C252)

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to 50 μs and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 (SK19) to DC.
- Connect a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
- Check that no overshoot is visible (maximum pulse top errors 2 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table:

Position AMPL switch SK17 (18)	Signal to Y_A (Y_B) BU3 (5)	Adjust with	Trace height
2 mV/div	12 mV	C52 (C252)	6 div + or −2 %
5 mV/div	30 mV	C52 (C252)	6 div + or −2 %
10 mV/div	60 mV	C52 (C252)	6 div + or −2 %
20 mV/div	120 mV	C52 (C252)	6 div + or −2 %
50 mV/div	300 mV	C52 (C252)	6 div + or −2 %
.1 V/div	600 mV	C52 (C252)	6 div + or −2 %
.2 V/div	1,2 V	C28 (C228)	6 div + or −2 %
.5 V/div	3 V	C28 (C228)	6 div + or −2 %
1 V/div	6 V	C28 (C228)	6 div + or −2 %
2 V/div	12 V	C33 (C233)	6 div + or −2 %
5 V/div	30 V	C33 (C233)	6 div + or −2 %
10 V/div	60 V	C33 (C233)	6 div + or −2 %

- Set AMPL switches SK17 and SK18 to .1 V/div.
- Apply a square-wave voltage of 1,2 V_{p-p} repetition rate 10 kHz, rise time not exceeding 200 ns, to Y_A, input socket BU3 via a 2:1 dummy measuring probe consisting of a 1 MOhm resistor and a 30 pF trimmer in parallel. If higher voltages are available, a 10:1 attenuator probe may be used.
- Adjust the trimmer of the dummy probe for optimum square-wave response.
- Apply the input signal via the dummy probe to Y_B input socket BU5.
- Check that the top of the displayed pulse is straight; if necessary, readjust trimmer C235 (Fig. 3.19.).
- Connect, via the dummy probe, a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
- Check that neither overshoot nor rounding is visible (maximum pulse top errors 3 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table

Position AMPL switch SK17 (18)	Signal to 2:1 dummy	Adjust with	Trace height
.2 V/div	2,4 V	C29 (C229)	6 div + or −2 %
.5 V/div	6 V	C29 (C229)	6 div + or −2 %
1 V/div	12 V	C29 (C229)	6 div + or −2 %
2 V/div	24 V	C34 (C234)	6 div + or −2 %
5 V/div	60 V	C34 (C234)	6 div + or −2 %
10 V/div	60 V	C34 (C234)	3 div + or −3 %

3.2.4.7. Square-wave response (C901, C1001, C902, C1002, C62, C262, R113, R313)

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to .2 µs and TIME/div potentiometer R2 to CAL.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Set AC-0-DC switch SK16 (SK19) to AC.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns.
- Check the square-wave response. The pulse top errors must not exceed 3 %, maximum permissible overshoot is 2 %; if necessary, readjust trimmers C901 (C1001), C902 (C1002) and C62 (C262) or select a different value for resistor R113 (R313).
- Set AMPL switch SK17 (SK18) to 0.2 mV/div.
- Decrease the input voltage to 12 mV.
- Check that the pulse top errors do not exceed 3 % and the overshoot more than 2 %.

3.2.4.8. Bandwidth of the vertical amplifiers

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Check the bandwidth at a trace height of 6 div in accordance with the following table

Input sine wave on Y_A (Y_B) socket	*Frequency*	*Required trace height*
600 mV_{p-p}	100 kHz	6 div
600 mV_{p-p}	10 MHz	at least 4,2 div

3.2.4.9. Signal delay equality

Note: This check is only necessary if a new delay line has been fitted.

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 auto switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AC-0-DC switch SK16 (SK19) to AC.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 µs/div and TIME/div potentiometer R2 to CAL.
- Pull TB-MAGN. switch SK1 to position 5x.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns to input sockets Y_A BU3 and Y_B BU5. The connection cables to the input sockets should have the same length and characteristics.
- Make the pictures coincide with the aid of control knobs Y POSITION.
- Check that there is no difference in delay time between the amplifiers of channels Y_A and Y_B (0,1 div is acceptable). If necessary, reduce the length of one of the delay lines.

3.2.4.10. H.F. deflection and cross-talk

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR switches SK14 and SK15.
- Set AMPL switch SK17 (SK18) to 50 mV/div and AMPL potentiometer R4 (R5) to CAL.
- Apply a sine-wave voltage of 1,2 V_{p-p}, frequency 3 MHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the peaks of the signal can be displayed fairly undistortedly within the graticule, using POSITION potentiometer R11 (R12).
- Set AMPL switches SK17 & SK18 to .1 V/div and AMPL potentiometers R4 & R5 to CAL.
- Apply a sine-wave signal 1,2 V, frequency 3 MHz, to Y_A input socket BU3.
- Set AC-0-DC switch SK19 to 0.
- Check that the height of the Y_B trace does not exceed 0,2 div.
- Set AMPL switches SK17 & SK18 to 50 mV/div and AMPL potentiometers R4 & R5 to CAL.
- Apply the input signal to Y_B input socket BU5.
- Set AC-0-DC switch SK16 to 0.
- Check that the height of the Y_A trace does not exceed 0,2 div.

3.2.5. TRIGGERING

3.2.5.1. Trigger pre-amplifier (R414)

- Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set AC-0-DC switch SK16 to AC.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Set LEVEL potentiometer R3 to such a position that the trace starts at the zero level of the sine-wave.
- Depress DC switch SK12.
- Check that the trace starts at the same point; if necessary, readjust potentiometer R414 (Fig. 3.[illegible]).
- Decrease the input voltage to 80 mV.
- Adjust LEVEL potentiometer R3 for a triggered display.
- Check that the display is still triggered when AC switch SK11 is depressed.
- Depress BEAM SELECTOR switch B SK15, Y_B switch SK5 and DC switch SK12.
- Apply the 80 mV input signal to Y_B socket BU5.
- Set AMPL switch SK18 to .1 V/div and AMPL potentiometer R5 to CAL.
- Adjust LEVEL potentiometer R3 for a triggered display.
- Depress AC switch SK11; the starting point of the trace must not move more than 1 div.

3.2.5.2. Long-tailed pair circuit (R424)

- Depress Y_A switch SK4, – switch SK9, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 to AC.
- Apply a sine-wave voltage of 80 mV_{p-p}, frequency 2 kHz, to Y_A socket BU3.
- Check that the display remains stationary when LEVEL potentiometer R3 is rotated from fully anti-clock to fully clockwise; if necessary, readjust potentiometer R424 (Fig. 3.17.).

3.2.5.3. Trigger slope

- Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Adjust LEVEL potentiometer R3 for a stationary display.
- Check that the display starts with the positive slope of the signal.
- Depress – switch SK9.
- Check that the display starts with the negative slope of the signal.

3.2.5.4. Level range with external triggering

- Depress EXT switch SK6, AC switch SK11, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to 10 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave voltage of 20 V_{p-p}, frequency 2 kHz, to both TRIGG input socket BU2 and Y_A input socket BU3.
- Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
- Depress – switch SK9 and repeat the check.

3.2.5.5. Level and level range

- Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave voltage of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Check that the starting point of the trace moves upwards when LEVEL potentiometer R3 is turned clockwise.
- Check that the starting point of the trace can be shifted over 5 div by means of LEVEL potentiometer R3.
- Depress AC switch SK11.

– Set AMPL switch SK17 to 50 mV/div.
– Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
– Check AMPL SK17 switch to 20 mV/div.
– Check that the time-base generator does not cut out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.

3.2.5.6. Mains triggering

– Depress EXT switch SK6, + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
– Set TIME/div switch SK2 to 20 ms and TIME/div potentiometer R2 to CAL.
– Apply a voltage with the mains frequency to Y_A input socket BU3; trace height 1 div.
– Check that the oscilloscope displays a moving sine wave.
– Depress MAINS switch SK7.
– Check that the display is stationary.

3.2.5.7. Trigger sensitivity

– Set AC-0-DC switches SK16 and SK19 to DC.
– Set LEVEL potentiometer R3 to obtain a stationary display.
– Set TIME/div switch SK2 so that a reasonable number of cycles is displayed.
– Check the trigger sensitivity in accordance with the following table.

Input signal to	*Frequency (sine wave)*	*Depress source switch*	*Depress mode switch*	*Depress BEAM SELECTOR*	*Triggering at*
Y_A BU3	20 Hz	Y_A SK4	AUTO SK10	A SK14	0,8 div
	10 MHz				0,8 div
	20 Hz		AC SK11		0,8 div
	10 Hz				0,8 div
	5 Hz		DC SK12		0,8 div
	10 MHz				0,8 div
Y_B BU5	20 Hz	Y_B SK5	AUTO SK10	B SK15	0,8 div
	10 MHz				0,8 div
TRIGG BU2 & Y_B BU5	20 Hz	EXT SK6		B SK15	0,8 V
	10 MHz				0,8 V

3.2.5.8. Single-sweep operation

– Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
– Depress WRITE switch SK25.
– Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
– Set AMPL switch SK17 to 50 mV/div.
– Set TIME/div switch SK2 to 50 ms/div.
– Apply a sine-wave of 600 mV, frequency 1 kHz to Y_A input socket BU3.
– Depress AUTO switch SK10 and Y_A switch SK4.
– Set AC-0-DC switch SK16 to AC.
– Set LEVEL potentiometer R3 to its mid-position.
– Depress SINGLE switch SK13 (RESET lamp LA4 is out).
– Push RESET button SK26 (RESET lamp LA4 is out).
The sweep runs only once, and displays a trace. If necessary, readjust the stability, for this see point 3.2.3.1.
– Depress AC switch SK11.
– Set AC-0-DC switch SK16 to 0.
– Push RESET button SK26, and ascertain that its associated lamp (LA4) lights.
– Set AC-0-DC switch SK16 to AC.
The sweep runs only once, after the sweep is completed the RESET lamp (LA4) goes out.

3.2.6. TIME-BASE GENERATOR AND HORIZONTAL AMPLIFIER

Note: For adjustment of the stability (R553) see point 3.2.3.1.

3.2.6.1. Time coefficients (R534, R539, R618)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10, X MAGN switch SK1 and BEAM SELECTOR switch A SK14.
- Set TIME/div potentiometer R4 to CAL.
- Set LEVEL potentiometer R3 to its mid-position.
- Set TIME/div switch SK2 to .5 ms.
- Check that the length of the time-base is 10 to 10,5 div, if necessary, readjust potentiometer R618 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 μs.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R534 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 ms.
- Change the repetition time of the input signal to 20 ms.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R539 (Fig. 3.17.).
- Check that in the other positions of TIME/div switch SK2 the 8 centre periods have a total width of 8 div + or −4 % (the repetition time of the input signal must always correspond to the setting of TIME/div switch SK2).
- Check that the length of the time-base line is 10 to 12 div in all positions of TIME/div switch SK2.
- Check that the control range of TIME/div potentiometer R2 is 1:2,6 to 1:5.

3.2.6.2. Magnification and shift (R617)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10 and BEAM SELECTOR A SK14.
- Set TIME/div switch SK2 to 20 μs and TIME/div potentiometer R2 to CAL.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Pull X MAGN switch SK1 to x5.
- Shift every cycle on to the screen by means of X POSITION potentiometer R1 and check that each cycle has a width of 5 div + or −2 %; if necessary, readjust potentiometer R617 (Fig. 3.17.).
- Check that with X POSITION potentiometer R1 the beginning and the end of the time-base line can be displayed within the graticule.
- Set TIME/div switch SK2 to .2 μs.
- Change the repetition time of the input signal to .2 μs.
- Check that the widths of all periods are equal within + or −2 %.

3.2.7. MAINS VOLTAGE FLUCTUATIONS

- Vary the mains voltage + and −10 % with respect to the nominal mains voltage as indicated by the voltage adapter.
- Check that the vertical and horizontal deflection are not affected and that the brightness does not change.

3.2.8. BEAM SELECTION

- Depress X MAGN switch SK1 to x1.
- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 1 ms.
- Set AMPL switches SK17 and SK18 to .1 V/div.
- Depress BEAM SELECTOR switch A SK14.
- Check that only the channel Y_A time-base line is visible.
- Release BEAM SELECTOR switch A SK14 and depress B SK15.
- Check that only the channel Y_B time-base line is visible.

3.2.9. X-Y OPERATION (R601)

- Depress AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR SWITCHES A SK14 and B SK15.
- Set TIME/div switch SK2 to 5 ms.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set POSITION potentiometer R11 to its mid-position.
- Set AC-0-DC switch SK16 to AC.
- Set X POSITION potentiometer R1 to such a position that the time-base lines start at the beginning of the measuring graticule.
- Centre the Y_B time-base line by means of POSITION potentiometer R12.
- Set TIME/div switch SK2 to position X via Y_A.
- Check that the spot is displayed in the centre of the screen; tolerance + or −5 div.
- Check that no Y_A trace is visible, also when POSITION potentiometer R11 is rotated.
- Apply a sine-wave voltage of 800 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Centre the trace by means of X POSITION potentiometer R1.
- Check that the trace width is 8 div + or −0,4 div; if necessary, readjust potentiometer R601 (Fig. 3.17.).
- Increase the frequency of the input voltage to 1 MHz.
- Check that the trace width is at least 6 div.

3.2.10. OUTPUT SOCKETS

3.2.10.1. Calibration voltage on CAL socket BU1 (R761)

- Check, with the aid of an accurate peak-peak voltmeter, that the voltage on CAL socket BU1 has a value of 600 mV_{p-p} + or −0,5 %; if necessary, readjust potentiometer R761 (Fig. 3.17.).
- Check that the pulse does not show overshoot and that the repetition frequency is 2 kHz + or −20 %.

3.2.10.2. Time-base voltage on TB OUT socket BU6

- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 2 ms.
- Check that the amplitude of the sawtooth voltage on TB OUT socket BU6 is 6 V + or −20 %, if terminated with a resistor of 1 MΩ.

Fig. 3.16. Adjusting and dismantling

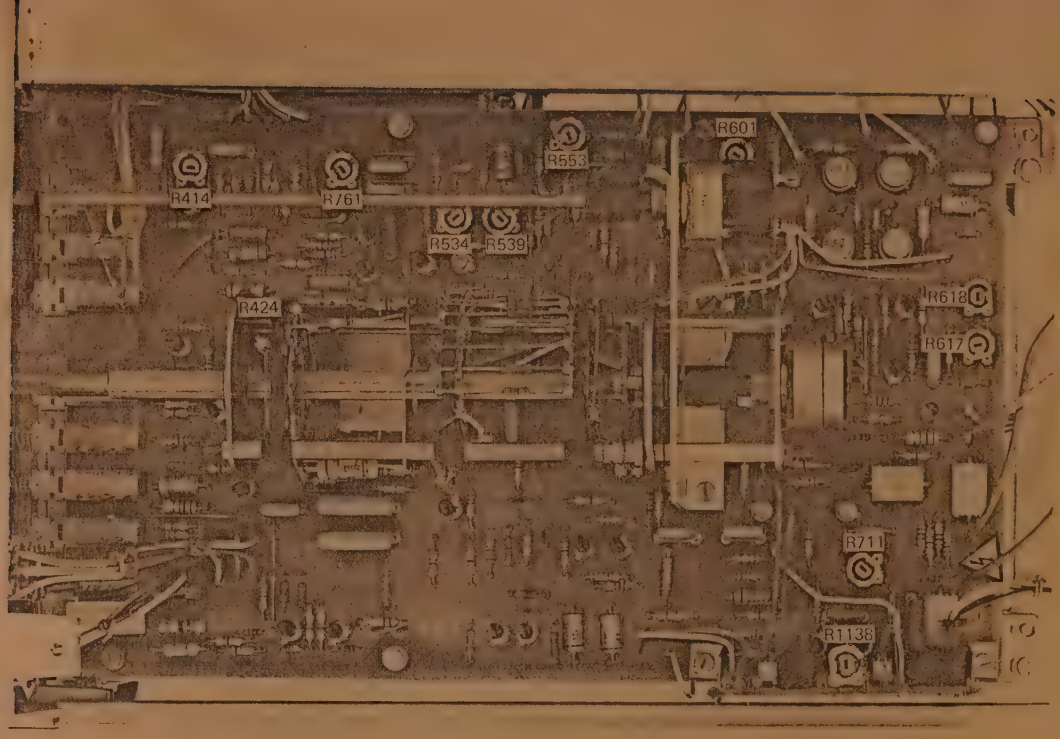


Fig. 3.17. Adjusting

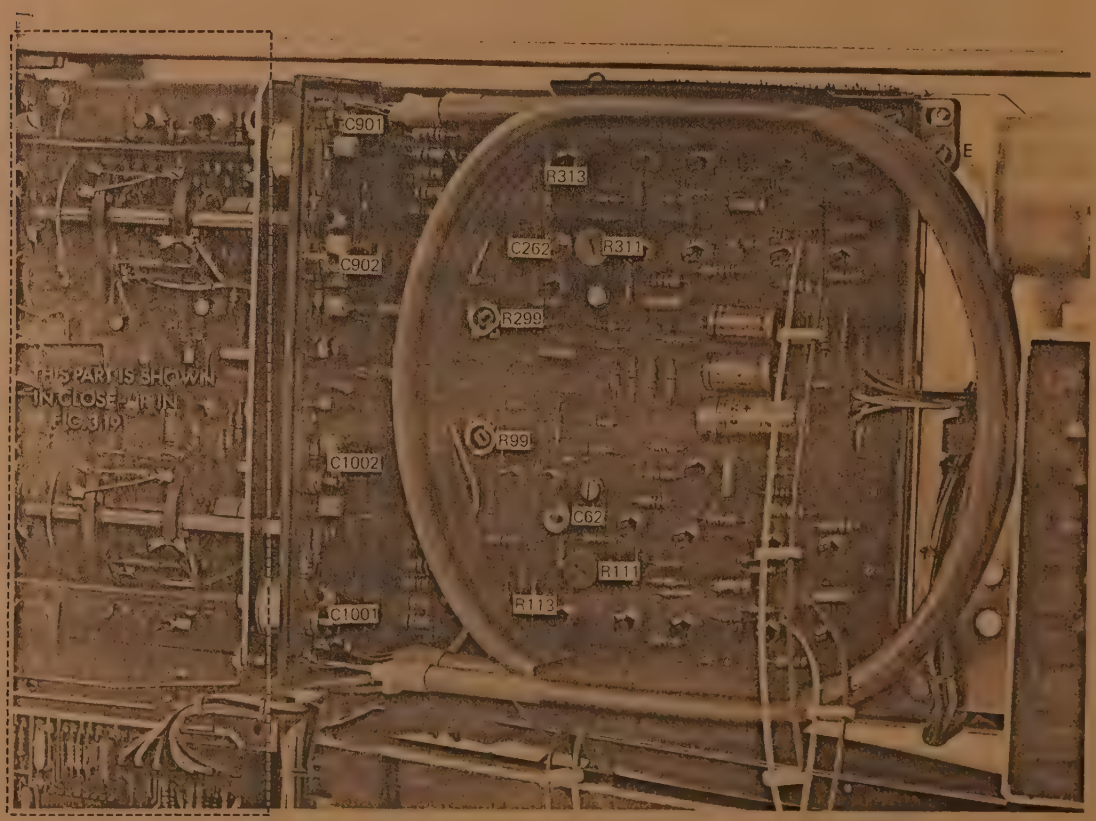
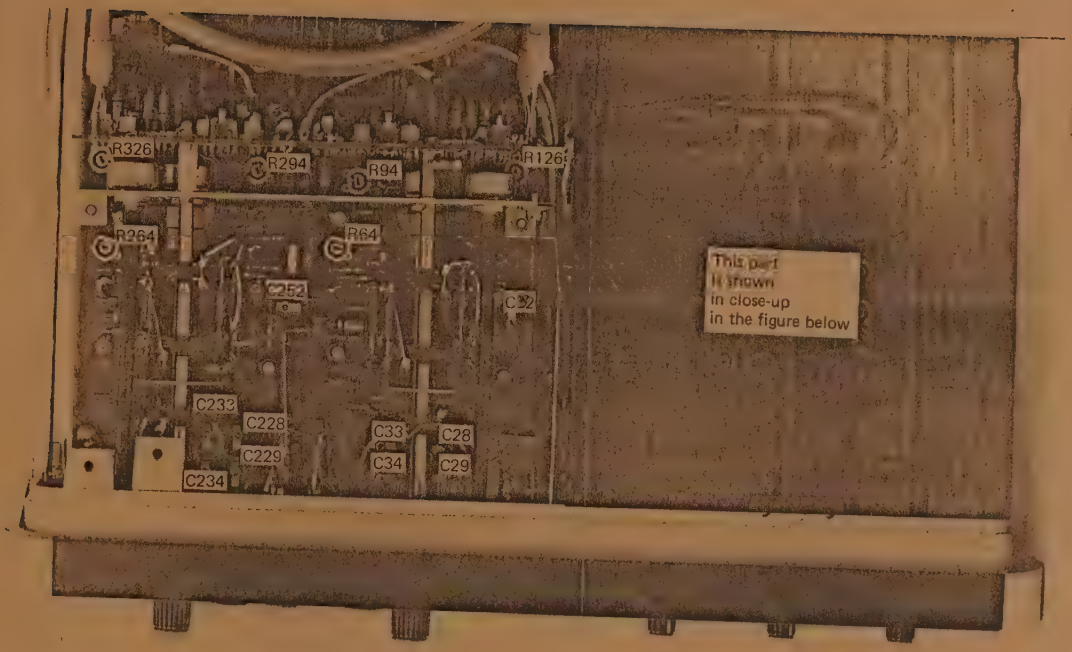
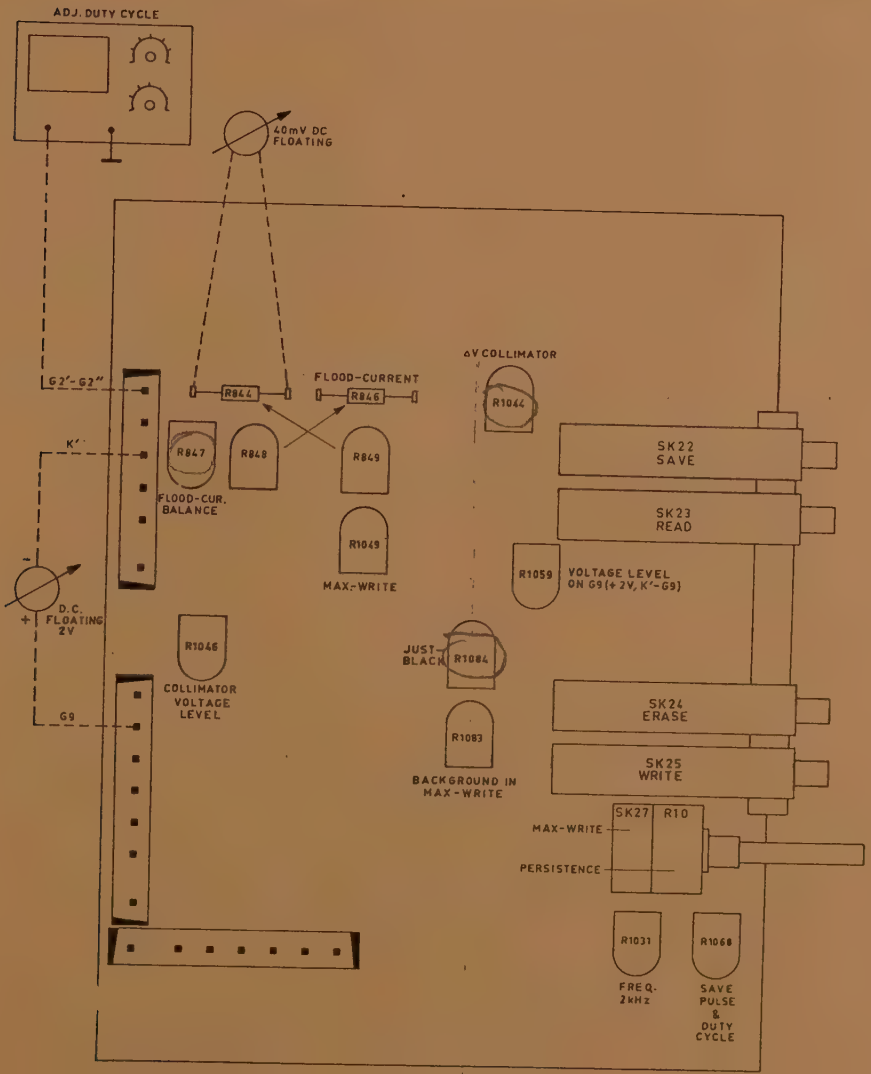


Fig. 3.18. Adjusting and dismantling


R326
R294
R94
R126
R264
R64
C252
C32
This part
is shown
in close-up
in the figure below
C233
C228
C33
C28
C229
C34
C29
C234


ADJ. DUTY CYCLE
40mV DC
FLOATING
ΔV COLLIMATOR
R1044
G2'-G2"
R844
FLOOD-CURRENT
R846
K'
R847
R848
R849
FLOOD-CUR.
BALANCE
R1049
MAX-WRITE
SK22
SAVE
SK23
READ
R1059
VOLTAGE LEVEL
ON G9(+2V, K'-G9)
D.C.
FLOATING
2V
R1046
COLLIMATOR
VOLTAGE
LEVEL
G9
JUST
BLACK
R1084
R1083
BACKGROUND IN
MAX-WRITE
SK24
ERASE
SK25
WRITE
SK27
R10
MAX-WRITE
PERSISTENCE
R1031
FREQ.
2kHz
R1068
SAVE
PULSE
&
DUTY
CYCLE

3.3. Dismantling the instrument

3.3.1. WARNING

The opening of parts of the instrument or the removal of covers is likely to expose live conductors.
The instrument must, therefore, be disconnected from all voltage sources before any opening of parts or removal of covers is started.
If the E.H.T. connector of the c.r.t. is disconnected, both connector and c.r.t. must be discharged immediately by shortening them to earth.

3.3.2. KNOBS

3.3.2.1. Knobs of Y POSITION potentiometers R11 & R12 and AC-0-DC switches SK16 & SK19

These knobs can be pulled off the shaft.

3.3.2.2. Single knobs (Fig. 3.20.)

– Remove cap A.
– Slacken screw B.
– Pull the knob off the shaft.

3.3.2.3. Double knobs (Fig. 3.20.)

– Remove cap A.
– Slacken screw B.
– Pull the inner knob off the shaft.
– Slacken nut C.
– Pull the outer knob off the shaft.

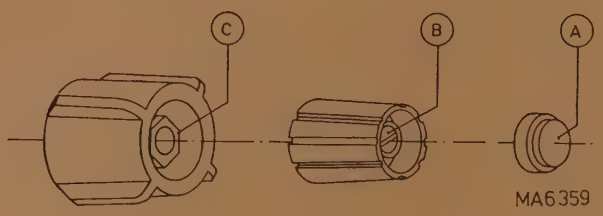


Fig. 3.20. Knobs

3.3.3. BEZEL

– Slightly lift the lower part of the bezel and swivel it upwards.
– Subsequently mask, contrast filter and measuring graticule can be removed.

3.3.4. CABINET PLATES

Top and bottom cabinet plates can be taken off after removing four screws for each plate.

3.3.5. PILOT LAMP

- Remove the bezel with graticule, filter and mask.
- Squeeze lamp holder flanges slightly inwards and push the lamp holder out of the frame. Be careful not to mechanically load the soldering tags of the lamp holder, as they break easily.
  The bulb is then accessible:

To refit:

- Push the lamp holder back in its opening until the hooks on the flanges snap over the frame.

3.3.6. TEXT PLATE OF C.R.T. CONTROLS

- Remove the bezel with graticule filter and mask.
- Remove the knobs of the PERSISTENCE, FOCUS and INTENS potentiometers.
- Remove the fixing nut around the shaft of the INTENS potentiometer.

3.3.7. STORAGE UNIT

- Unplug all connectors on the storage board.
- Remove the bezel with graticule, filter and mask.
- Remove one screw J (Fig. 3.22.).
- Remove the two recessed-head screws G (Fig. 3.22.) and belonging clamping devices with which the storage board is fitted to the front panel.
- Slide the board out of the instrument.

3.3.8. TIME-BASE UNIT

- Remove the X POSITION, TIME/div and LEVEL knobs.
- Unplug all connectors on the time-base board (a few connectors can be unplugged at the vertical amplifier board).
- Remove two screws A (Fig. 3.21.).
- Remove two screws B (Fig. 3.21.).
- Remove two screws and nuts C (Fig. 3.21.).
- Lift the unit out of the instrument.
- When refitting the unit, make sure that the screening plate between time-base and vertical amplifier unit clicks into place over the cross bars of the frame.

Note:

In order to maintain the mechanical strength of the oscilloscope, the time-base unit and the vertical amplifier unit must not be removed at the same time.

3.3.9. VERTICAL AMPLIFIER UNIT

- Remove the AC-0-DC, AMPL and POSITION knobs.
- Set the AC-0-DC switches SK16 & 19 to 0.
- Remove all connectors on the amplifier board.
- Remove two screws D (Fig. 3.22.).
- Remove two screws E (Fig. 3.18.).
- Remove two screws C (Fig. 3.21.).
- Lift the unit out of the instrument.
- When refitting the unit, make sure that the AC-0-DC switches are in 0 position and that the screening plate between time-base and amplifier unit clicks into place over the cross bars of the frame.

3.3. Dismantling the instrument

3.3.1. WARNING

The opening of parts of the instrument or the removal of covers is likely to expose live conductors.
The instrument must, therefore, be disconnected from all voltage sources before any opening of parts or removal of covers is started.
If the E.H.T. connector of the c.r.t. is disconnected, both connector and c.r.t. must be discharged immediately by shortening them to earth.

3.3.2. KNOBS

3.3.2.1. Knobs of Y POSITION potentiometers R11 & R12 and AC-0-DC switches SK16 & SK19

These knobs can be pulled off the shaft.

3.3.2.2. Single knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the knob off the shaft.

3.3.2.3. Double knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the inner knob off the shaft.
- Slacken nut C.
- Pull the outer knob off the shaft.

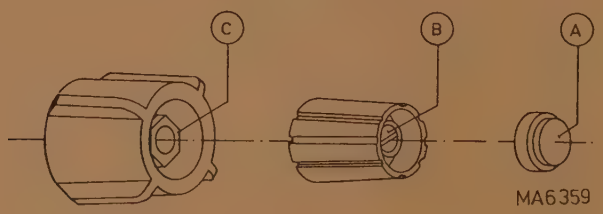


Fig. 3.20. Knobs

3.3.3. BEZEL

- Slightly lift the lower part of the bezel and swivel it upwards.
- Subsequently mask, contrast filter and measuring graticule can be removed.

3.3.4. CABINET PLATES

Top and bottom cabinet plates can be taken off after removing four screws for each plate.

3.3.5. PILOT LAMP

- Remove the bezel with graticule, filter and mask.
- Squeeze lamp holder flanges slightly inwards and push the lamp holder out of the frame. Be careful not to mechanically load the soldering tags of the lamp holder, as they break easily.
  The bulb is then accessible:

To refit:

- Push the lamp holder back in its opening until the hooks on the flanges snap over the frame.

3.3.6. TEXT PLATE OF C.R.T. CONTROLS

- Remove the bezel with graticule filter and mask.
- Remove the knobs of the PERSISTENCE, FOCUS and INTENS potentiometers.
- Remove the fixing nut around the shaft of the INTENS potentiometer.

3.3.7. STORAGE UNIT

- Unplug all connectors on the storage board.
- Remove the bezel with graticule, filter and mask.
- Remove one screw J (Fig. 3.22.).
- Remove the two recessed-head screws G (Fig. 3.22.) and belonging clamping devices with which the storage board is fitted to the front panel.
- Slide the board out of the instrument.

3.3.8. TIME-BASE UNIT

- Remove the X POSITION, TIME/div and LEVEL knobs.
- Unplug all connectors on the time-base board (a few connectors can be unplugged at the vertical amplifier board).
- Remove two screws A (Fig. 3.21.).
- Remove two screws B (Fig. 3.21.).
- Remove two screws and nuts C (Fig. 3.21.).
- Lift the unit out of the instrument.
- When refitting the unit, make sure that the screening plate between time-base and vertical amplifier unit clicks into place over the cross bars of the frame.

Note:

In order to maintain the mechanical strength of the oscilloscope, the time-base unit and the vertical amplifier unit must not be removed at the same time.

3.3.9. VERTICAL AMPLIFIER UNIT

- Remove the AC-0-DC, AMPL and POSITION knobs.
- Set the AC-0-DC switches SK16 & 19 to 0.
- Remove all connectors on the amplifier board.
- Remove two screws D (Fig. 3.22.).
- Remove two screws E (Fig. 3.18.).
- Remove two screws C (Fig. 3.21.).
- Lift the unit out of the instrument.
- When refitting the unit, make sure that the AC-0-DC switches are in 0 position and that the screening plate between time-base and amplifier unit clicks into place over the cross bars of the frame.

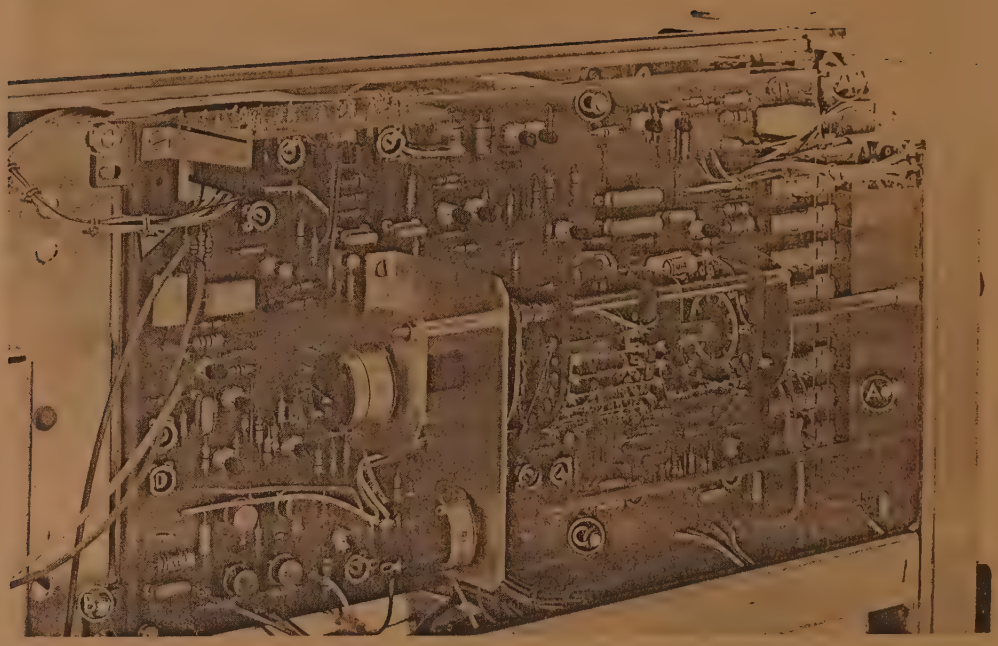


Fig. 3.21. Dismantling

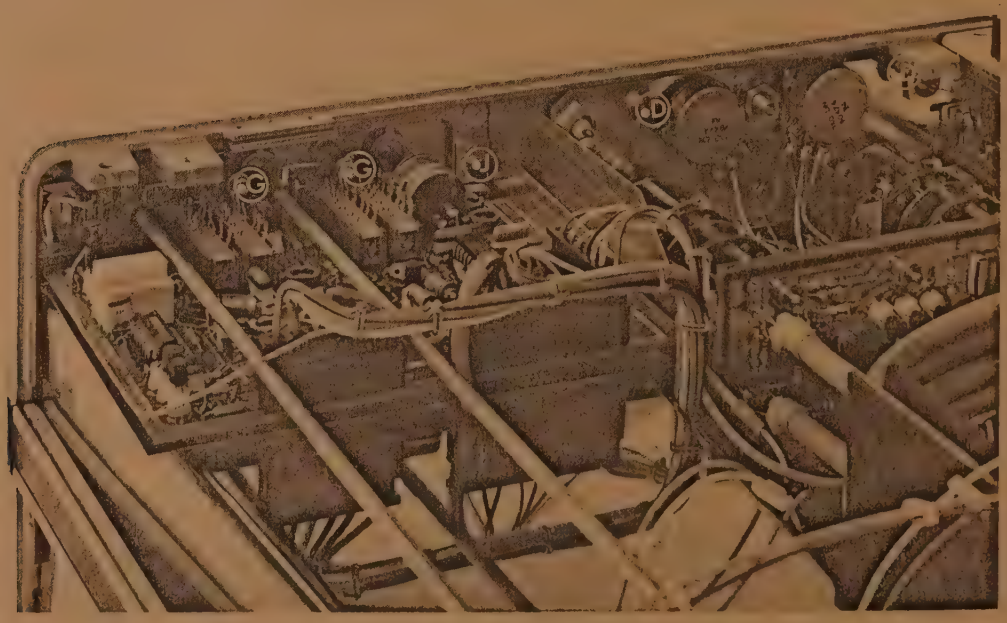


Fig. 3.22. Dismantling

3.3.10. MAIN TEXT PLATE

- Remove all knobs except those of the c.r.t. controls.
- Set the AC-0-DC switches SK16 & 19 to 0.
- Remove the time-base unit.
- Remove the earth connector BU4.
- Remove the retaining clips of the bearings for the X POSITION and the LEVEL potentiometer, and the bearings themselves.
- Unplug the connector of the CAL socket.
- Remove the retaining clip of the CAL socket, and the CAL socket itself.
- Take the text plate out of the front panel.

3.3.11. CATHODE-RAY TUBE

Attention: Be very careful with the side connections of the c.r.t. If these pins are bent, the c.r.t. is likely to develop a gas leak.

- Slacken the brace around the c.r.t. neck by means of screw F.
- Slacken screws K.
- Remove the tube base.
- Remove magnets T and pull the yoke (Y) from the c.r.t. neck.
- Slacken the four screws H and remove the plates.
- Remove the mu-metal screening tube S.
- Remove the bezel with graticule, filter and mask.
- Remove the rubber collar around the front side of the c.r.t.
- Push the c.r.t. to the rear side of the oscilloscope and remove the connections around the c.r.t. neck.
- Push the c.r.t. to the front side of the oscilloscope and remove the connections (discharge connectors and c.r.t. immediately by shortening them to earth).
- Carefully withdraw the c.r.t. through the front panel of the instrument.
- Refitting of the c.r.t. is done in the reverse order.
- Move the c.r.t. in such a way that the tube face is flush with the front of the oscilloscope.
- If the yoke and the rubber sleeve around the neck of the c.r.t. must be slid over the neck of a remplacement tube, the use of industrial talcum powder is strongly recommended.

Attention: After replacement of the tube, the aperatus must be checked and adjusted according to chapter 3.2. "Checking and adjusting". Then, after a burning in time of about 100 hours the apparatus must be checked and eventually adjusted again.

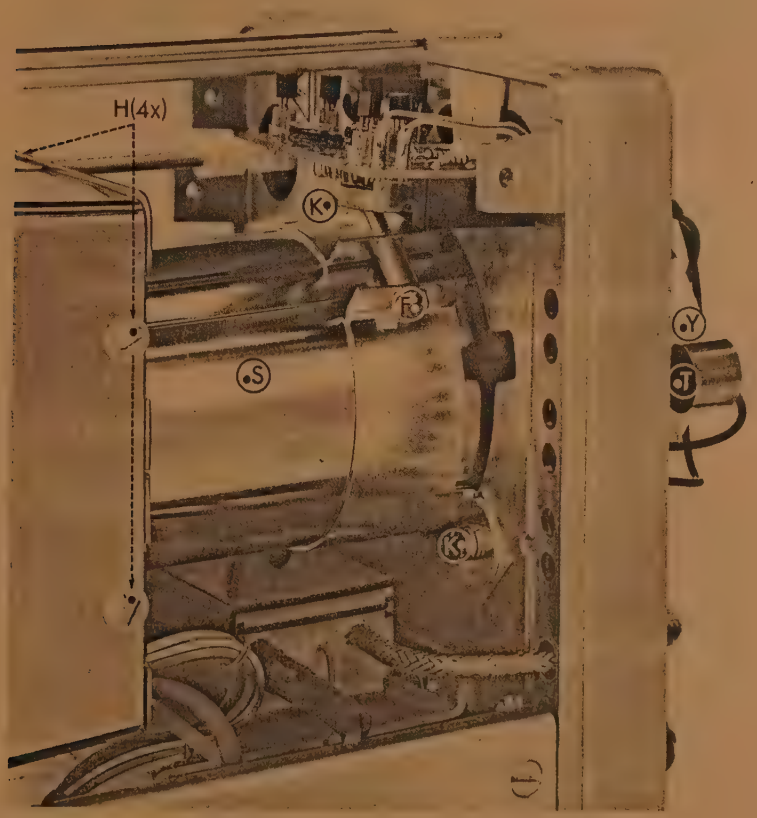


Fig. 3.23. Dismantling

3.3.12. MAINS TRANSFORMER

– Remove the rear cover (three screws X, Fig. 2.1.).
– Unsolder and unplug the relevant connections.
– Remove the three screws L (Fig. 3.24.).
– Take the transformer with voltage adapter and capacitor out of the instrument.

3.3.13. POWER SUPPLY BOARD

If only the components on the board must be made accessible, proceed as follows:
– Remove the rear cover (three screws X, Fig. 2.1.).
– Remove the rear panel with the sockets, by removing the three screws and spacers M (Fig. 3.15.).
– Unplug all connectors on the power supply board.
– If necessary, remove valve holder, magnets and the yoke of the c.r.t. (Fig. 3.23. & 3.25.).
– Remove the five screws N (Fig. 3.15.).
– Swivel the board out of the instrument (Fig. 3.25.).

Fig. 3.24. Dismantling

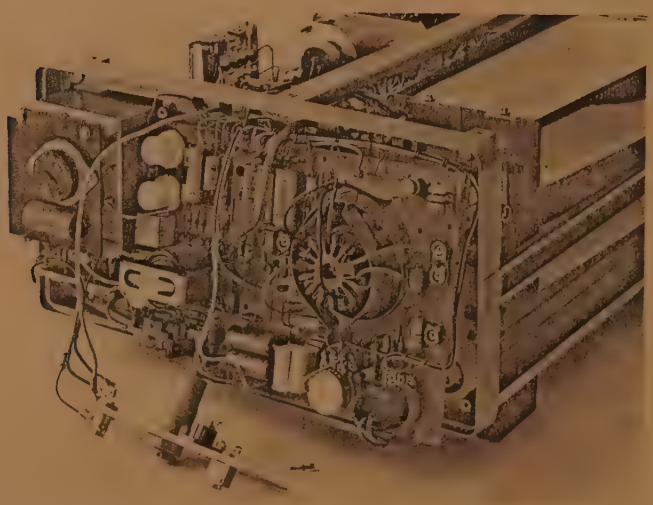


Fig. 3.25. Supply unit swiveled out

If the wiring board must be replaced, also unsolder the remaining connection wires along the sides of the board, including the connection of the mains cable to the POWER ON switch and the connections to the valve holder of the c.r.t.

Note: When replacing the board, make sure that the shafts of the FOCUS and INTENS-potentiometers fit properly in the coupling bushes 0 (Fig. 3.16.).

3.3.14. VOLTAGE QUADRUPLER

- Remove the rear cover (three screws X, Fig. 2.1.).
- Remove the E.H.T. connector and discharge the E.H.T. and c.r.t. immediately by shortening them to earth.
- Unsolder the E.H.T. lead at point P on the supply unit (Fig. 3.15.).
- Unsolder the earth wire of the quadrupler.
- Slightly squeeze the quadrupler flanges inside the cable compartment together and pull the quadrupler out.

3.3.15. REPLACING A PUSH-BUTTON SWITCH

- Remove the storage unit in accordance with section 3.3.7. for replacing a switch in this unit.
- Remove the time-base unit in accordance with section 3.3.8., for replacing a switch in this unit.
- Remove the vertical amplifier unit in accordance with section 3.3.9., for replacing a switch in this unit.
- Straighten the 4 retaining plugs of the relevant switches as shown in Fig. 3.26.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-wiring board.
- Bend the 4 retaining lugs back to their original positions.

N.B.: The YA and + switch are not soldered, so it is sufficient to just straighten the 4 retaining lugs to remove them.

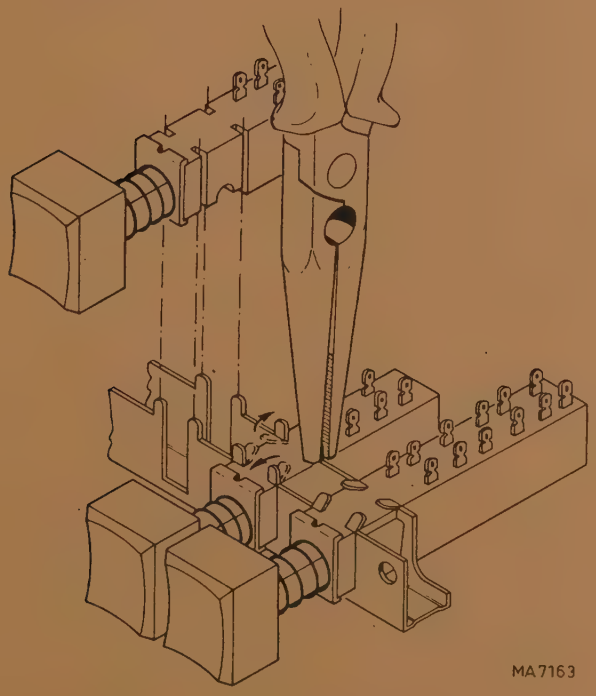


Fig. 3.26. Replacing a push-button switch

3.4. Information for assistance in fault-finding

3.4.1. MAINS TRANSFORMER DATA

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram in the form of a table.

3.4.2. VOLTAGES AND WAVEFORMS IN THE INSTRUMENT

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator and storage unit are shown at the relevant points on the circuit diagram.

The waveforms have been measured under the following conditions:
- Input signal on Y_A socket BU3: 2 kHz sine-wave voltage for 6 cm deflection.
- LEVEL potentiometer R3 in mid-position.
- TIME/div switch SK2 to .2 ms and X MAGN switch SK1 to x1.
- Y_A, + and AUTO push-buttons SK4, SK8 and SK10 depressed.
- AMPL switch SK17 to 1 V/div.

The voltage values are typical and may slightly differ per instrument.

3.4.3. REMARK

In case of a defect is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:
- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.5. Information concerning accessories

3.5.1. FRONT COVER

This is a plastic cover to protect the oscilloscope front during transport. The cover contains storage space for two passive probes and two BNC to 4 mm adapters. This storage space is accessible after the cover plate has been removed. To this end, bend the lugs A (Fig. 3.27.) slightly inwards and lift off the cover plate.

Fig. 3.27. Front cover

3.5.2. ADAPTER PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm banana plugs.

Fig. 3.28. Adapter PM 9051

3.5.3. ATTENUATOR PROBE SETS PM 9326 and PM 9327 (Fig. 3.29.)

These passive probe sets are equal but for the length of the probe cable, which is 1,15 m for the PM 9326 and 2 m for the PM 9327.

The sets consist of:

1 probe cable	Fig. 3.29. item 1
1 earth lead 15 cm	Fig. 3.29. item 2
1 earth lead 30 cm	Fig. 3.29. item 3
1 measuring probe 1:1 (black)	Fig. 3.29. item 4
1 test pin	Fig. 3.29. item 5
1 test hook	Fig. 3.29. item 6
1 attenuator probe 1:10 (grey)	Fig. 3.29. item 7
1 test clip	Fig. 3.29. item 8
1 box	Fig. 3.29. item 9

The measuring probe and the earth lead can be simply pulled from the cable. The test clip, test pin and test hook are screwed on to the measuring probe.

For ordering numbers of these parts, see list 3.6.3.1.

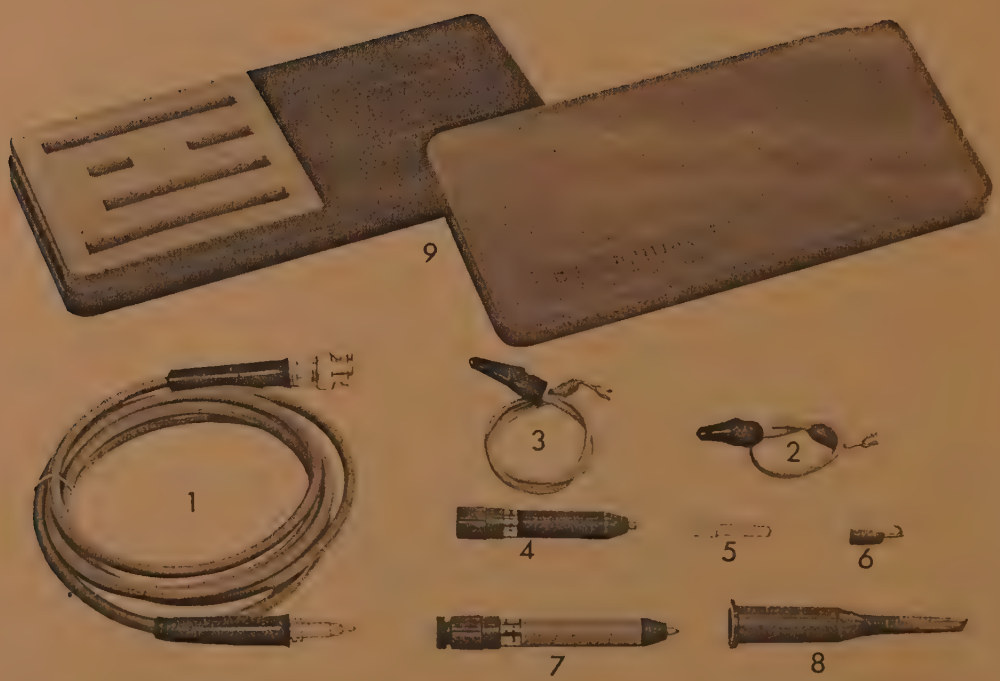


Fig. 3.29. Attenuator probe set PM 9326 (PM 9327)

3.5.3.1. Technical data

Attenuation	1:10 ±3 %
Input impedance	10 MOhm//10 pF
Max. permissible input voltage	1000 V_{p-p}

Maximum d.c. component 500 V with the blocking capacitor included into the circuit.

3.5.3.2. Adjustment (Fig. 3.30.)

– Unscrew the probe locking nut by turning it anti-clockwise.
– Rotate the probe body to change the capacitance while watching the display for the desired waveform.
– When compensation is completed, carefully turn the locking nut clockwise, to lock it without disturbing the adjustment.

The attenuator probe causes distortion if it has not been properly adjusted.

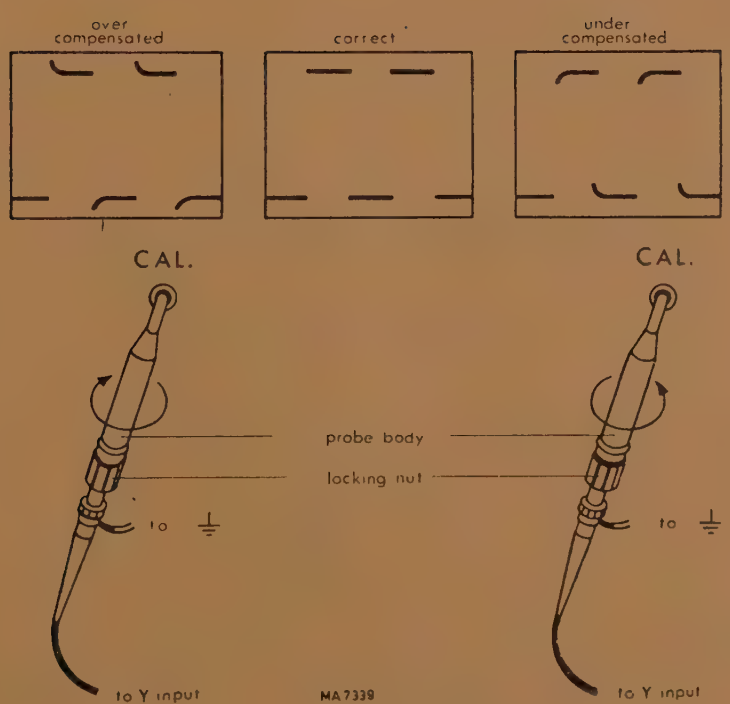


Fig. 3.30. Adjusting an attenuator probe

3.5.4. ATTENUATOR PROBE SETS PM 9336 and PM 9336L

The PM 9336 is a 10x attenuator probe, designed for oscilloscopes up to 25 MHz, having a BNC input jack and 10 to 35 pF input capacitance, paralleled by 1 MΩ. The PM 9336L is a similar probe with a cable length of 2.5 m.

The set consists of:

1 probe assembly	Fig. 3.31. item 1
5 soldering terminals	Fig. 3.31. item 2
1 test hook	Fig. 3.31. item 3
2 spare test hook sleeves	Fig. 3.31. item 4
1 protective cap	Fig. 3.31. item 5
1 probe holder	Fig. 3.31. item 6
2 probe tips	Fig. 3.31. item 7
1 earthing cord	Fig. 3.31. item 8
1 box	item 9

For ordering numbers of these parts, see list 3.6.3.2.

Fig. 3.31. Attenuator probe set PM 9336 (PM 9336L)

3.5.4.1. Technical data

Attenuation	1:10 ±3 %		
Input resistance	PM 9336	10 MOhm	±2 %
	PM 9336L	10 MOhm	±2 %
Input capacitance	PM 9336	11 pF	±1 pF
	PM 9336L	14 pF	±1 pF
Maximum allowable input voltage	500 V (D.C. + A.C. peak)		

3.5.4.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to socket CAL of the oscilloscope.
A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples

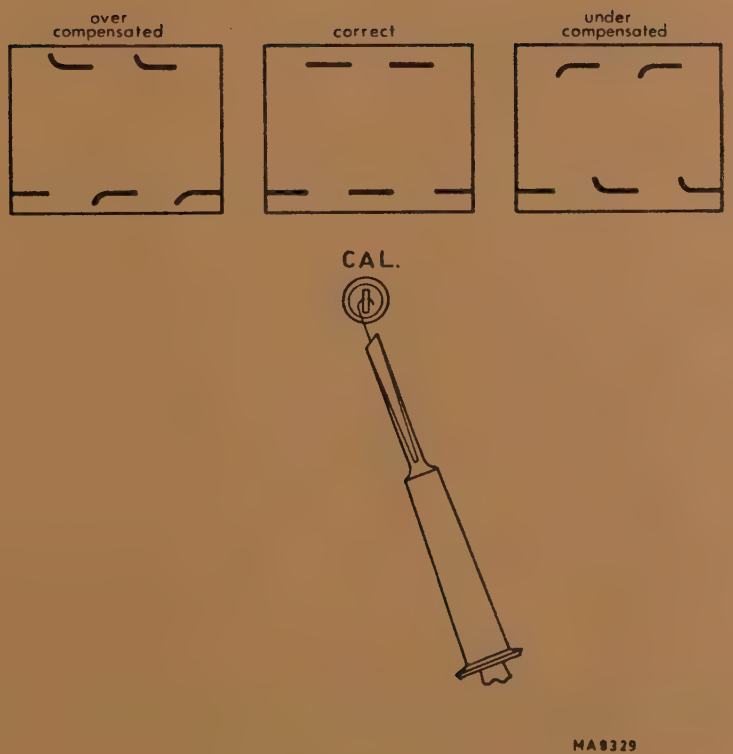


Fig. 3.32. Probe compensation

3.5.5. 1:1 PROBE SETS PM 9335 and PM 9335L

The PM 9335 is a passive probe without signal attenuation for use with oscilloscope, counters and voltmeters having a high input impedance and a BNC input socket.
The cable design is such that the reflections due to the instrument's capacitive load are absorbed.
The useful range of this probe is restricted to d.c. and l.f. applications (up to 10 MHz).
The PM 9335L is a similar probe with a cable length of 2,5 m.

The set consists of:

1 test hook	Fig. 3.33. item 1
2 spare test hook sleeves	Fig. 3.33. item 2
2 spare probe tips	Fig. 3.33. item 3
1 protective cap	Fig. 3.33. item 4
1 earthing lead	Fig. 3.33. item 5
1 probe holder	Fig. 3.33. item 6
1 probe assembly	Fig. 3.33. item 7
1 box	item 8

For ordering numbers of these parts, see list 3.6.3.3.

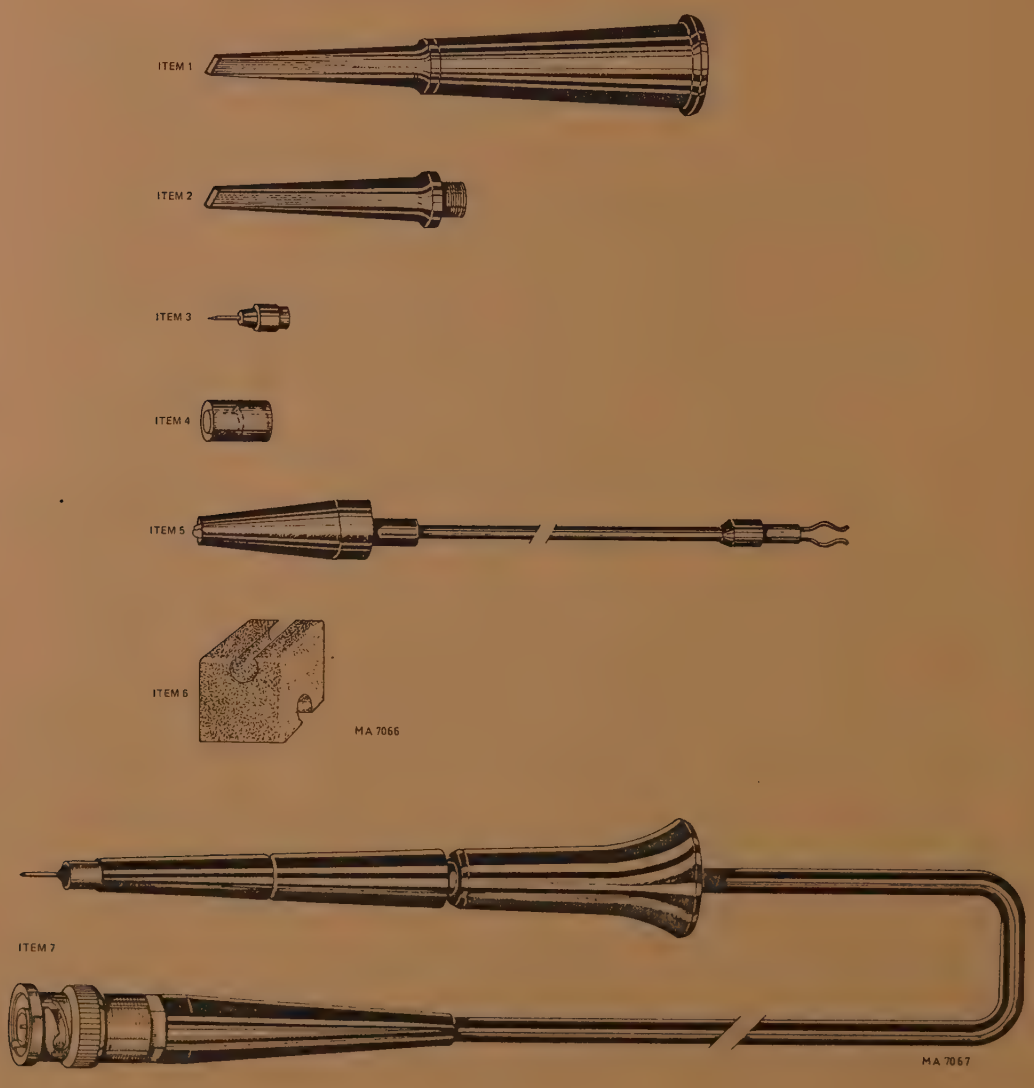


Fig. 3.33. Probe set PM 9335

3.5.5.1. Technical data

Attenuation	1:1
Input resistance	1 MOhm
Input capacitance	45 ±5 pF + input cap. of measuring instrument

Max. allowable input voltage	
D.C.	500 V
A.C. peak-to-peak	500 V derating at higher frequencies with $\frac{500\ V}{MHz}$
A.C. peak + D.C.	500 V

Dimensions	**L**	**W**	**H**
Probe body	105		mm
Cable	1.5		m
Box	230	104	24 mm

3.5.6. 2 kV ATTENUATOR SET PM 9358

The PM 9358 is a 100x attenuator probe which can handle signals up to 2 kV_{rms}. The probe has been designed for use with oscilloscopes having a bandwidth up to 150 MHz, a BNC input jack and an input impedance of 1 MΩ paralleled by 14 to 21 pF.

The set consists of:

1 probe assembly	Fig. 3.34. item 1
5 soldering terminals	Fig. 3.34. item 2
1 test hook	Fig. 3.34. item 3
1 spare test hook sleeve	Fig. 3.34. item 4
1 protective cap	Fig. 3.34. item 5
1 insulating cap	Fig. 3.34. item 6
1 probe holder	Fig. 3.34. item 7
2 spare test pins	Fig. 3.34. item 8
1 earthing cord	Fig. 3.34. item 9
1 box	item 10

For ordering numbers of these parts, see list 3.6.3.4.

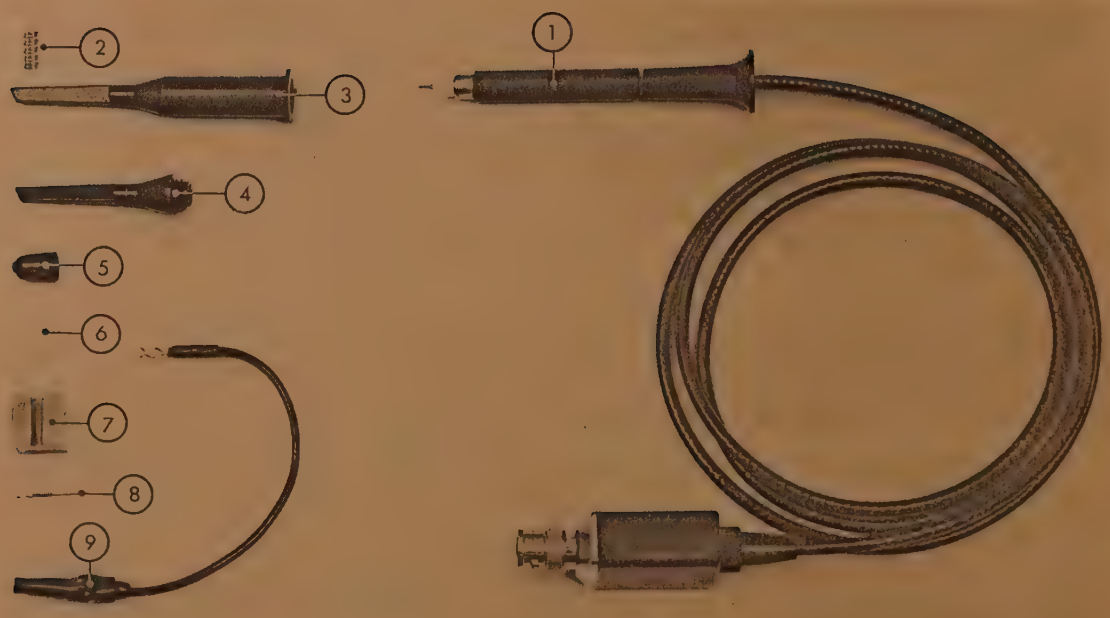


Fig. 3.34. Attenuator probe set PM 9358

3.5.6.1. Technical data

Attenuation		1:100 ±2 %
Input resistance		20 MOhm ±3 %
Input capacitance		2 pF ±0.3 pF
Max. allowable voltage DC or AC_{rms}		
Continuous	2 kV	
Under pulsed conditions	2 kV	Duty cycle 50 - 100 % dv/dt ⩽ 1000 V/ns Pulse rep. frequency ⩽ 1 MHz
	3 kV	Duty cycle 25 - 50 % dv/dt ⩽ 500 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 100 ms
	4 kV	Duty cycle 0 - 25 % dv/dt ⩽ 200 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 20 ms
Sine waves continuous	5,6 kV_{p-p}	For frequencies up to 1 MHz

3.5.6.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary. Connect the measuring pin to socket CAL of the oscilloscope. A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples:

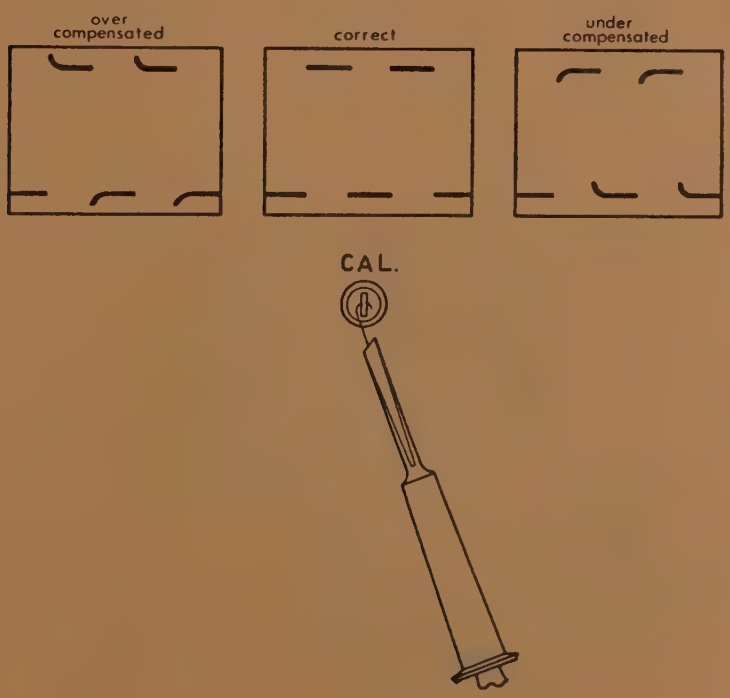


Fig. 3.35. Probe compensation

3.5.7. SET OF EAGLE CLIPS PM 9333

PM 9333 Set of eagle clips especially designed to probe difficult to reach signal sources, all types of wrapped wiring etc.

Each set contains:

10 eagle clips fitting the probes PM 9335, PM 9336 and PM 9336L
10 adapter pieces fitting the probes PM 9326 and PM 9327
10 adapter pieces fitting the micro-miniature probe PM 9352

Fig. 3.36. Adapter set PM 9333

3.5.8. MULTI-PURPOSE CAMERA PM 9380

Camera PM 9380 has been designed to photograph oscilloscope displays in a quick and simple way.
It incorporates the Polaroid instant photographic process which has the advantage that you can see the picture a few moments after you took it.

Fig. 3.37. Multi-purpose camera PM 9380

3.5.9. ADAPTER PM 9379

This adapter forms the connection between camera PM 9380 and oscilloscope PM 3234. The dimensions of the adapter are such, that the camera automatically focussed when the camera-adapter combination is held against the front of the oscilloscope.

NOTE

Together with this adapter, a supplementary lens PM 9373 must be used.

Fig. 3.38. Adapter PM 9379

3.6. Parts lists and diagrams (Subject to alteration without notice)

3.6.1. MECHANICAL PARTS

Item	*Fig.*	*Qty*	*Ordering number*	*Description*
1	3.39	1	5322 268 14052	Calibration terminal BU1 compl.
2	3.39	1	5322 268 10031	Calibration contact pin BU1
3	3.39	1	5322 325 84011	Grommet for BU1
4	3.39	1	5322 492 60799	Spring for BU1
5	3.39	1	5322 532 54198	Insulating ring for BU1
6	3.39	5	5322 414 34119	Control knob (R1, R2, R3, R4, R5)
7	3.39	4	5322 414 74014	Cover for control knob (grey)
8	3.39	3	5322 414 74016	Cover for control knob (blue)
9	3.39	3	5322 414 34081	Switch knob (SK3, SK17, SK18)
10	3.39	10	5322 276 14101	Push-button switch (SK4...SK13)
11	3.39	10	5322 414 24846	Knob for SK4...SK13
12	3.39	1	5322 455 84036	Text plate, front (big)
13	3.39	1	5322 276 10398	Reset pushbutton (compl.)
14	3.39	4	5322 267 10004	BNC socket (BU2, BU3, BU5, BU6)
15	3.39	4	5322 506 14001	Nut for BNC socket
16	3.39	3	5322 532 24319	Padding ring for BU2, BU3, BU5
17	3.39	2	5322 276 14103	Push-button switch (SK14, SK15)
18	3.39	2	5322 414 24845	Knob for SK14, SK15
19	3.39	2	5322 277 14047	Lever switch (SK16, SK19)
20	3.39	2	5322 414 25052	Knob for SK16 and SK19
21	3.39	1	5322 498 54046	Carrying handle
22	3.39	2	5322 500 14152	Screw for carr. handle
23	3.39	1	5322 462 54067	Tilting-bracket
24	3.39	2	5322 462 44067	Hinge for tilting-bracket
25	3.39	4	5322 462 40252	Foot
26	3.39	1	5322 535 80523	Earthing terminal (BU4)
27	3.39	1	5322 505 14178	Nut for BU4
28	3.39	2	5322 414 34108	Control knob (R11, R12)
29	3.39	2	5322 492 64377	Clamping spring for R11, R12
30	3.39	3	5322 414 34075	Control knob (R8, R9, R10)
31	3.39	3	5322 414 74015	Cover for control knob (R8, R9, R10)
32	3.39	3	5322 414 74028	Nut cover (R8, R9, R10)
33	3.39	4	5322 276 14102	Push-button switch (SK22...SK25)
34	3.39	1	5322 414 24911	Knob (red)
35	3.39	3	5322 414 14011	Knob (grey)
36	3.39	1	5322 381 10152	Lens
37	3.39	1	5322 455 84037	Text plate front (small)
38	3,39	1	5322 450 14002	Graticule
39	3.39	1	5322 480 34034	Contrast filter (grey)
39	3.39	1	5322 480 34043	Contrast filter (amber)
40	3.39	1	5322 480 34091	Contrast filter (blue)
41	3.39	1	5322 447 94228	Mask
42	3.39	1	5322 451 34002	Bezel
43	3.39	1	5322 447 94186	Cabinet plate (top)
44	3.39	1	5322 447 94167	Cabinet plate (bottom)
45	3.40-.41	2	5322 459 84004	Insert
45a	3.40	1	5322 447 94282	Front cast
45b	3.40	1	5322 447 94283	Rear cast

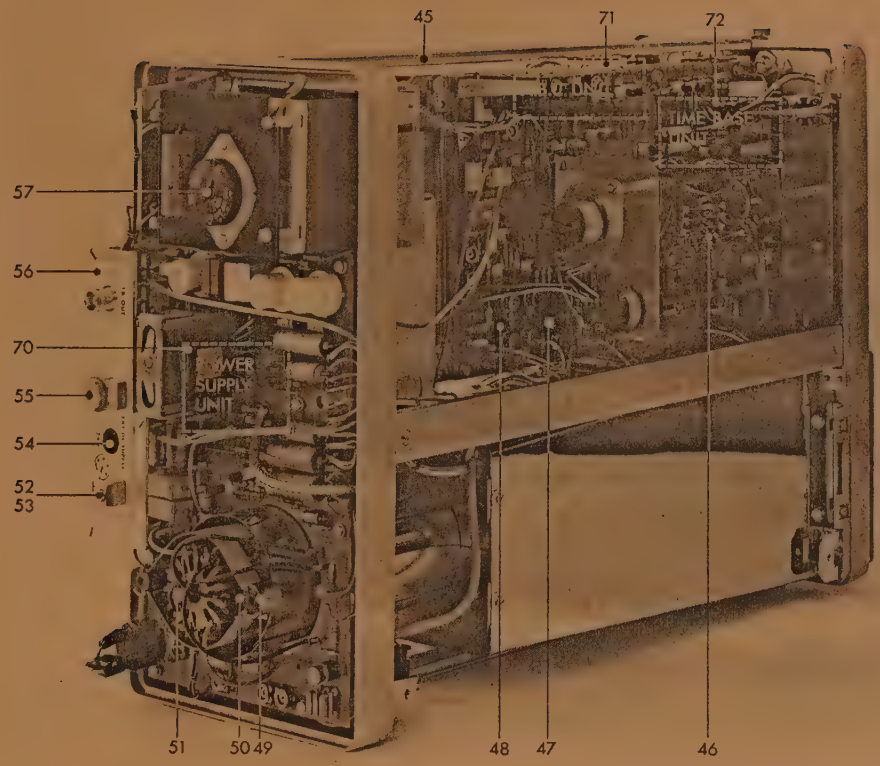


Fig. 3.41. Bottom view showing item numbers

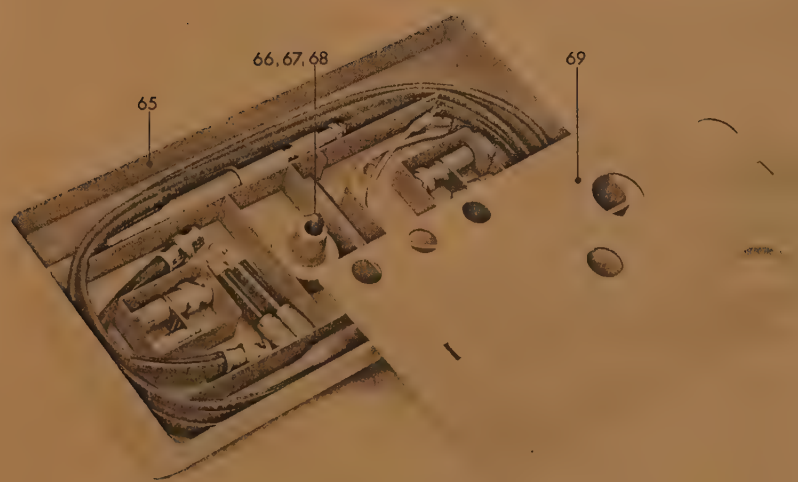


Fig. 3.42. Front cover showing item numbers

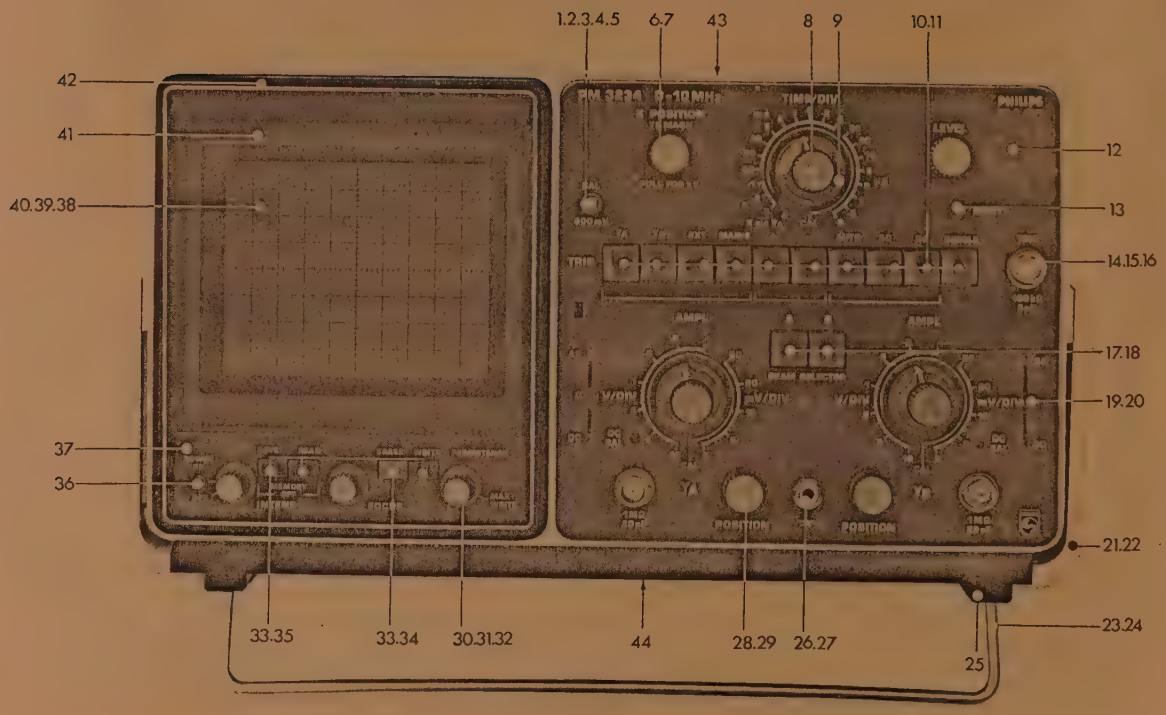


Fig. 3.39. Front view showing item numbers

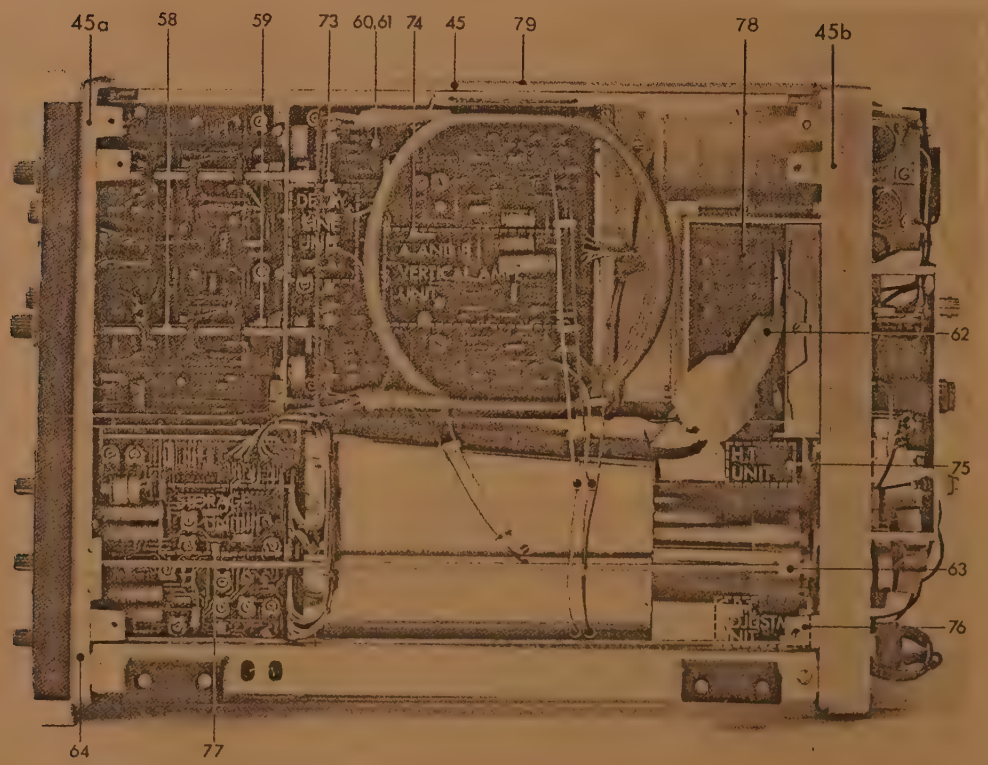


Fig. 3.40. Top and rear view showing item numbers

Item	Fig.	Qty	Ordering number	Description
46	3.40	1	5322 105 34009	Time-base switch, complete (SK2)
47	3.40	108	5322 255 40089	Transistor socket
48	3.40	6	5322 255 40038	Transistor socket
49	3.40	2	5322 492 64452	Fixing spring (magnet)
50	3.40	2	5322 526 24026	Cylindrical magnet
51	3.40	1	5322 255 70159	Valve socket for CRT
52	3.40	1	5322 466 85168	Earthing terminal
53	3.40	1	5322 405 94046	Clamp for earthing terminal
54	3.40	1	5322 267 40127	Socket 6 cont. (BU8)
55	3.40	1	5322 256 34019	Fuse holder
56	3.40	1	5322 455 84038	Text plate, rear
57	3.41	1	4822 272 10079	Voltage adaptor
58	3.41	2	5322 105 34008	Attenuator switch, complete (SK17, SK18)
59	3.41	2	5322 532 34079	Coupling piece for R4, R5
60	3.41	2	5322 462 70715	Plastic cap
61	3.41	2	5322 255 44053	S Clip (non-insulated)
61	3.41	2	5322 255 40106	S Clip (insulated)
62	3.41	1	5322 321 14001	Mains flex
63	3.41	2	5322 532 24321	Coupling piece for R8, R9
64	3.41	3	5322 255 24015	Lamp holder for La1
65	3.42	1	5322 447 94091	Front cover
66	3.42	1	5322 414 34086	Key
67	3.42	1	5322 492 54152	Compression spring
68	3.42	1	4822 530 70126	Fixing spring (Front cover)
69	3.42	1	5322 455 84009	Plate
70	3.40	1	5322 216 54107	Printed wiring board of power supply unit, complete with components
71	3.40	1	5322 216 54184	Automatic brightness cont. unit
72	3.40	1	5322 216 54108	Printed wiring board of time-base unit, complete with components (incl. time-base switch)
73	3.41	1	5322 216 54132	Delay line unit
74	3.41	1	5322 216 54131	Printed wiring board of vertical amplifier unit, complete with components (incl. att. switches, delay line unit and delay line)
75	3.41	1	5322 216 54109	High tension unit
76	3.41	1	5322 216 54147	C.R.T. adjustment unit
77	3.41	1	5322 216 54148	Storage unit
78	3.40		5322 447 94478	Plastic cover for mains cable compartment
—	—		5322 492 64637	Hook for C.R.T.
—	—		5322 466 64183	Rubber for C.R.T.
79	3.40		5322 466 85794	Grey aluminium side strip

3.6.1.1. Miscellaneous parts

Item	Ordering number	Description
B1	5322 131 24027	C.R.T. type L14-131 GH/55
LA1	5322 134 40268	Lamp 28 V, 40 mA (Type 387)
LA4	4822 134 40167	Lamp 5 V, 60 mA
VL1	4822 253 30016	Fuse 400 mA delayed action
VL802	4822 253 30024	Fuse, 1,6 A delayed action
T801	5322 146 14081	Mains transformer

— Starting with the /15 version a new plastic coupling piece is used for X POS potentiometer R1
This new coupling piece (5322 532 34079) can only be used in combination with a modified potentiometer R1 with ordering number 5322 101 60066.

3.6.2. Electrical parts

3.6.2.1. Capacitors

POSNR	DESCRIPTION			ORDERING CODE
C 1001	CAPACITOR,TRIMM	20PF		4822 125 50045
C 1002	CAPACITOR,TRIMM	20PF		4822 125 50045
C 1003	CAPACITOR,CERAM	220PF 10	100	4822 122 30094
C 1004	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 1006	CAPACITOR,CERAM	470PF 10	100	4822 122 30034
C 1007	CAPACITOR,CERAM	10PF 2	100	4822 122 31054
C 1010	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 1011	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 1012	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 1013	CAPACITOR,FOIL	1UF 10%	100V	5322 121 40197
C 1014	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 1015	CAP,ELECTROLYT.	47UF-10+50	10	4822 124 20678
C 1016	CAPACITOR,FOIL	330NF 10%	100V	4822 121 40257
C 1017	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 1018	CAPACITOR,CERAM	330PF 10	500	4822 122 31165
C 1019	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 1020	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 1021	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 1022	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 1023	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 1024	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 1025	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 1026	CAPACITOR,CERAM	2,7NF 10	100	4822 122 30057
C 1027	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 1028	CAP,ELECTROLYT.	1,5UF-10+50	63	4822 124 20723
C 1029	CAP,ELECTROLYT.	33UF-10+50	6,3	4822 124 20669
C 1030	CAPACITOR,CERAM	22PF 2	100	4822 122 31063
C 226	CAPACITOR,FOIL	100NF 10%	630V	4822 121 40149
C 228	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 229	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 230	CAPACITOR,CERAM	5,6PF 0,25PF	500	4822 122 31191
C 231	CAPACITOR,CERAM	33PF 2	500	4822 122 31202
C 232	CAPACITOR,CERAM	2,7PF 0,25PF	500	4822 122 31187
C 233	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 234	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 235	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 236	CAPACITOR,FOIL			5322 121 54228
C 237	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 238	CAPACITOR,CERAM	5,6PF 0,25PF	500	4822 122 31191
C 250	CAPACITOR,CERAM	56PF 2	100	4822 122 31521
C 251	CAPACITOR,FOIL	82PF 1%	630V	5322 121 54086
C 252	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 253	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 256	CAPACITOR,CERAM	180PF 10	100	4822 122 30113
C 257	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 258	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 259	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 26	CAPACITOR,FOIL	100NF 10%	630V	4822 121 40149
C 261	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 262	CAPACITOR,TRIMM	20PF		4822 125 50045
C 263	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 264	CAPACITOR,CERAM	680PF 10	100	4822 122 30053
C 266	CAPACITOR,CERAM	680PF 10	100	4822 122 30053
C 267	CAPACITOR,CERAM	47PF 2	100	4822 122 31072
C 273	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 274	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 276	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 277	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215

POSNR	DESCRIPTION			ORDERING CODE
C 278	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 279	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 28	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 281	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 282	CAP,ELECTROLYT.	220UF-10+50	16	4822 124 20693
C 283	CAP,ELECTROLYT.	470UF-10+50	25	4822 124 20784
C 284	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 285	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 286	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 29	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 30	CAPACITOR,CERAM	5,6PF 0,25PF	500	4822 122 31191
C 31	CAPACITOR,CERAM	33PF 2	500	4822 122 31202
C 32	CAPACITOR,CERAM	2,7PF 0,25PF	500	4822 122 31187
C 33	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 34	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 35	CAPACITOR,CERAM	3,9PF 0,25PF	500	4822 122 31217
C 36	CAPACITOR,FOIL			5322 121 54228
C 37	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 38	CAPACITOR,CERAM	5,6PF 0,25PF	500	4822 122 31191
C 400	CAPACITOR,CERAM	22PF 2	100	4822 122 31063
C 401	CAPACITOR,CERAM	0,82PF 0,25PF	500	4822 122 31193
C 402	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 403	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 404	CAPACITOR,CERAM	2,2NF 10	100	4822 122 30114
C 405	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 406	CAPACITOR,FOIL	1UF 10%	100V	5322 121 40197
C 407	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 408	CAPACITOR,FOIL	470NF 10%	250V	4822 121 40186
C 409	CAPACITOR,FOIL	470NF 10%	250V	4822 121 40186
C 410	CAP,ELECTROLYT.	4,7UF 50%	16V	4822 124 20686
C 411	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 415	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 416	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 417	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 50	CAPACITOR,CERAM	100PF 2	100	4822 122 31316
C 501	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 502	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 503	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 504	CAPACITOR,CERAM	15PF 2	100	4822 122 31058
C 505	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 506	CAP,ELECTROLYT.	4,7UF 50%	16V	4822 124 20686
C 507	CAPACITOR,CERAM	560PF 0	100	4822 122 30126
C 508	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 509	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 51	CAPACITOR,FOIL	82PF 1%	630V	5322 121 54086
C 510	CAPACITOR,CERAM	22PF 2	100	4822 122 31063
C 511	CAPACITOR,CERAM	1,5NF 10	100	4822 122 31221
C 512	CAPACITOR,CERAM	47PF 2	100	4822 122 31072
C 513	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 514	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 516	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 52	CAPACITOR,TRIMM	5,5PF		5322 125 54027
C 521	CAPACITOR,FOIL	4,7UF 10%	100V	4822 121 40266
C 522	CAPACITOR,FOIL			5322 121 54229
C 523	CAPACITOR,FOIL	5,6NF 1%	63V	4822 121 50543
C 524	CAP,ELECTROLYT.	2,2UF-10+50	63	4822 124 20724
C 526	CAPACITOR,FOIL	1NF 1%	250V	4822 121 50566
C 53	CAPACITOR,CERAM	33PF 2	100	4822 122 31067
C 54	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 55	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 56	CAPACITOR,CERAM	180PF 10	100	4822 122 30113
C 57	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 58	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 59	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 60	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239

POSNR	DESCRIPTION			ORDERING CODE
C 601	CAPACITOR,CERAM	180PF 2	100	5322 122 34144
C 602	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 603	CAPACITOR,CERAM	8,2PF 0,25PF	100	4822 122 31052
C 604	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 606	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 607	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 608	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 609	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 61	CAP,ELECTROLYT.	33UF-10+50	16	4822 124 20688
C 62	CAPACITOR,TRIMM	20PF		4822 125 50045
C 63	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 64	CAPACITOR,CERAM	680PF 10	100	4822 122 30053
C 66	CAPACITOR,CERAM	680PF 10	100	4822 122 30053
C 67	CAPACITOR,CERAM	47PF 2	100	4822 122 31072
C 68	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 69	CAPACITOR,CERAM	100PF 2	100	4822 122 31316
C 702	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 703	CAPACITOR,FOIL	15NF 10%	630V	4822 121 40406
C 704	CAPACITOR,FOIL	150NF 10%	250V	4822 121 40104
C 706	CAPACITOR,CERAM	1NF 10%	1600V	4822 121 40253
C 707	CAPACITOR,CERAM	1NF 10%	1600V	4822 121 40253
C 708	CAPACITOR,CERAM	27PF 2	100	4822 122 30045
C 709	CAPACITOR,CERAM	1NF 10%	1600V	4822 121 40253
C 73	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 74	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 750	CAPACITOR,FOIL	33NF 10%	400V	4822 121 40411
C 751	CAPACITOR,FOIL	22NF 10%	250V	4822 121 40407
C 752	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 753	CAP,ELECTROLYT.	10UF-10+50	25	4822 124 20697
C 754	CAP,ELECTROLYT.	15UF-10+50	16	4822 124 20687
C 756	CAPACITOR,CERAM	1NF 10	100	4822 122 30027
C 76	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 77	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 78	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 79	CAPACITOR,CERAM	0,68PF 0,25PF	100	4822 122 31215
C 80	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 801	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 802	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 804	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 805	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 806	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 807	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 808	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 809	CAPACITOR,CERAM	22NF-20+80	40	4822 122 30103
C 81	CAPACITOR,FOIL	47NF 10%	400V	4822 121 40239
C 810	CAPACITOR,PAPER	150NF 20%	250V	5322 121 44167
C 811	CAPACITOR,FOIL	1UF 10%	100V	5322 121 40197
C 812	CAPACITOR,FOIL	1UF 10%	100V	5322 121 40197
C 813	CAP,ELECTROLYT.	1,5UF-10+50	63	4822 124 20723
C 814	CAP,ELECTROLYT.	1,5UF-10+50	63	4822 124 20723
C 815	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 816	CAPACITOR,FOIL	100NF 10%	250V	4822 121 41161
C 817	CAP,ELECTROLYT.	6800UF-10+50	40	5322 124 70341
C 818	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 819	CAP,ELECTROLYT.	68UF-10+50	6,3	4822 124 20671
C 82	CAP,ELECTROLYT.	220UF-10+50	16	4822 124 20693
C 820	CAPACITOR,FOIL	10NF	630V	4822 121 41134
C 821	CAPACITOR,CERAM	100PF 2	100	4822 122 31316
C 822	CAPACITOR,HT	470PF 20%	4KV	5322 122 54004
C 823	CAPACITOR,HT	470PF 20%	4KV	5322 122 54004
C 824	CAP,ELECTROLYT.	33UF-10+50	40	4822 124 20712
C 825	CAP,ELECTROLYT.	100UF-10+50	10	4822 124 20679
C 826	CAPACITOR,FOIL	22NF 10%	1600V	4822 121 40196
C 827	CAPACITOR,FOIL	22NF 10%	1600V	4822 121 40196
C 828	CAP,ELECTROLYT.	22UF-10+50	250	4822 124 21136

POSNR	DESCRIPTION				ORDERING CODE
C 829	CAP,ELECTROLYT.	100UF-10+50		100	4822 124 20808
C 83	CAPACITOR,FOIL	150NF 10%		250V	4822 121 40104
C 830	CAP,ELECTROLYT.	33UF-10+50		40	4822 124 20712
C 831	CAP,ELECTROLYT.	470UF-10+50		25	4822 124 20784
C 832	CAP,ELECTROLYT.	33UF-10+50		16	4822 124 20688
C 833	CAP,ELECTROLYT.	220UF-10+50		16	4822 124 20693
C 834	CAP,ELECTROLYT.	33UF-10+50		16	4822 124 20688
C 836	CAP,ELECTROLYT.	220UF-10+50		16	4822 124 20693
C 837	CAPACITOR,HT	470PF 20%		4KV	5322 122 54004
C 838	CAPACITOR,HT	470PF 20%		4KV	5322 122 54004
C 839	CAPACITOR,CERAM	560PF 20%		10KV	5322 122 50075
C 84	CAPACITOR,FOIL	47NF 10%		400V	4822 121 40239
C 841	CAP,ELECTROLYT.	1000UF-10+50		10	4822 124 20768
C 842	CAP,ELECTROLYT.	1000UF-10+50		10	4822 124 20768
C 901	CAPACITOR,TRIMM	20PF			4822 125 50045
C 902	CAPACITOR,TRIMM	20PF			4822 125 50045
C 903	CAPACITOR,CERAM	220PF	10	100	4822 122 30094
C 904	CAPACITOR,FOIL	10NF		630V	4822 121 41134
C 906	CAPACITOR,CERAM	470PF	10	100	4822 122 30034
C 907	CAP,ELECTROLYT.	10UF-10+50		63	4822 124 20728
C 908	CAPACITOR,FOIL	47NF 10%		400V	4822 121 40239

3.6.2.2. Resistors

POSNR	DESCRIPTION					ORDERING CODE
R 1	POTM,CARB+SW.	2K2	LIN	0,25W	5322	101 64003
MODIFIED FOR VERSIONS /15 AND UP.						
R 1	POTM,CARB+SW.	2K2	LIN	0,25W	5322	101 60066
R 10	POTM,CARB+SW.	10K	20	0.25W	5322	101 44018
R 100	RESISTOR,M.FILM	100	5	CR25	4822	110 73081
R 1001	RESISTOR,M.FILM	1M	5	CR25	4822	110 73187
R 1002	RESISTOR,M.FILM	820	5	CR25	4822	110 73105
R 1003	RESISTOR,M.FILM	402	1	MR25	5322	116 54519
R 1004	RESISTOR,M.FILM	1,27K	1	MR25	5322	116 50555
R 1006	RESISTOR,M.FILM	47	5	CR25	4822	110 73072
R 1008	RESISTOR,M.FILM	820	5	CR25	4822	110 73105
R 1009	RESISTOR,M.FILM	470	5	CR25	4822	110 73098
R 101	RESISTOR,M.FILM	5,11K	1	MR25	5322	116 54595
R 1011	RESISTOR,M.FILM	825	1	MR25	5322	116 54541
R 1012	RESISTOR,M.FILM	3,6K	5	CR25	4822	110 70122
R 1013	RESISTOR,CARBON	300	5	CR25	4822	110 60093
R 1014	RESISTOR,M.FILM	13K	5	CR25	4822	110 70137
R 1016	RESISTOR,M.FILM	140	1	MR25	5322	116 55568
R 1017	RESISTOR,M.FILM	140	1	MR25	5322	116 55568
R 1018	RESISTOR,M.FILM	3,65K	1	MR25	5322	116 54587
R 1019	RESISTOR,M.FILM	47	5	CR25	4822	110 73072
R 102	RESISTOR,M.FILM	17,4K	0,1		5322	116 51828
R 1020	RESISTOR,M.FILM	348	1	MR25	5322	116 54515
R 1021	RESISTOR,M.FILM	3,9K	5	CR25	4822	110 73123
R 1022	RESISTOR,M.FILM	1,2K	5	CR25	4822	110 73109
R 1023	RESISTOR,M.FILM	3,48K	1	MR25	5322	116 55367
R 1024	RESISTOR,M.FILM	1,1K	1	MR25	4822	116 51236
R 103	RESISTOR,M.FILM	510	5	CR25	4822	110 70099
R 1031	POTM,TRIMMING	4,7K	20	0.05W	4822	100 10036
R 1032	RESISTOR,M.FILM	30K	5	CR25	4822	110 70146
R 1033	RESISTOR,HT	2,2M	5	VR25	4822	110 72196
R 1034	RESISTOR,M.FILM	14,7K	1	MR25	5322	116 54632
R 1035	RESISTOR,M.FILM	100	5	CR25	4822	110 73081
R 1036	RESISTOR,M.FILM	33,2K	1	MR25	4822	116 51259
R 1037	RESISTOR,M.FILM	4,7K	5	CR25	4822	110 73125
R 1038	RESISTOR,M.FILM	10K	5	CR25	4822	110 73134

POSNR	DESCRIPTION				ORDERING CODE
R 1039	RESISTOR,CARBON	300K	5	CR25	5322 110 60173
R 104	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 1041	RESISTOR,M.FILM	750K	5	CR25	4822 110 70184
R 1042	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 1043	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 1044	POTM,TRIMMING	10K	20	0.05W	4822 100 10035
R 1045	RESISTOR,M.FILM	27,4K	1	MR25	5322 116 50559
R 1046	POTM,TRIMMING	4,7K	20	0.05W	4822 100 10036
R 1047	RESISTOR,M.FILM	12K	5	CR25	4822 110 73136
R 1048	RESISTOR,M.FILM	261K	1	MR25	5322 116 54736
R 1049	POTM,TRIMMING	220K	20	0.05W	4822 100 10088
R 1050	RESISTOR,M.FILM	470K	5	CR25	4822 110 73178
R 1051	RESISTOR,M.FILM	27K	5	CR25	4822 110 73145
R 1052	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1053	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1054	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 1055	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1056	RESISTOR,M.FILM	33,2K	1	MR25	4822 116 51259
R 1057	RESISTOR,M.FILM	7,5K	1	MR25	5322 116 54608
R 1058	RESISTOR,M.FILM	10,5K	1	MR25	5322 116 50731
R 1059	POTM,TRIMMING	2,2K	20	0.05W	4822 100 10029
R 106	RESISTOR,CARBON	47	5	CR37	4822 110 53072
R 1060	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1061	RESISTOR,M.FILM	301K	1	MR25	5322 116 54743
R 1062	RESISTOR,M.FILM	4,22K	1	MR25	5322 116 50729
R 1063	RESISTOR,M.FILM	1K	1	MR25	4822 116 51235
R 1064	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 1066	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1067	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 1068	POTM,TRIMMING	10K	20	0.05W	4822 100 10035
R 1069	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 107	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 1071	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 1072	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 1073	RESISTOR,CARBON	300K	5	CR25	5322 110 60173
R 1074	RESISTOR,M.FILM	750K	5	CR25	4822 110 70184
R 1076	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 1077	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1078	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 108	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 1081	RESISTOR,M.FILM	1,8K	5	CR25	4822 110 73114
R 1082	RESISTOR,M.FILM	1,8K	5	CR25	4822 110 73114
R 1083	POTM,TRIMMING	47K	20	0.05W	4822 100 10079
R 1084	POTM,TRIMMING	4,7K	20	0.05W	4822 100 10036
R 1086	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 1087	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 1088	RESISTOR,M.FILM	82K	5	CR25	4822 110 73158
R 1089	RESISTOR,M.FILM	53,6K	1	MR25	5322 116 54674
R 109	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 1091	RESISTOR,M.FILM	120K	5	CR25	4822 110 73163
R 1092	RESISTOR,M.FILM	68K	5	CR25	4822 110 73156
R 1093	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 1094	RESISTOR,M.FILM	14K	1	MR25	5322 116 55571
R 1095	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 1096	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 1097	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1098	RESISTOR,M.FILM	1,1K	5	CR25	4822 110 70108
R 1099	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 11	POTM,CARBON	1K	20	0.25W	5322 101 24045
R 1101	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1102	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1103	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1104	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1105	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 1106	RESISTOR,M.FILM	1,5K	5	CR25	4822 110 73112

POSNR	DESCRIPTION				ORDERING CODE
R 1107	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 1108	RESISTOR,M.FILM	3,6K	5	CR25	4822 110 70122
R 1109	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 111	POTM,TRIMMING	470	20	0,5W	5322 101 14047
R 1110	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 1111	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1113	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1114	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 1116	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 1117	RESISTOR,M.FILM	1M	1	MR25	5322 116 55535
R 1118	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1119	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 112	RESISTOR,M.FILM	220	5	CR25	4822 110 73089
R 1121	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1122	RESISTOR,CARBON	100	5	CR37	4822 110 53081
R 1123	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 1124	RESISTOR,M.FILM	68K	5	CR25	4822 110 73156
R 1131	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1132	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 1133	RESISTOR,M.FILM	1,1K	5	CR25	4822 110 70108
R 1134	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 1136	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 1137	RESISTOR,M.FILM	22K	5	CR25	4822 110 73143
R 1138	POTM,TRIMMING	4,7K	20	0.05W	4822 100 10025
R 1139	RESISTOR,CARBON	300K	5	CR25	5322 110 60173
R 114	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 116	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 117	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 118	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 119	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 12	POTM,CARBON	1K	20	0.25W	5322 101 24045
R 121	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 122	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 123	RESISTOR,HT	5,6M	5	VR37	4822 110 42207
R 124	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 125	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 126	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 127	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 128	RESISTOR,M.FILM	909K	0,1		5322 116 51833
R 129	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 130	RESISTOR,M.FILM	18K	5	CR25	4822 110 73141
R 131	RESISTOR,M.FILM	510K	5	CR25	4822 110 70179
R 132	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 133	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 134	RESISTOR,M.FILM	120	5	CR25	4822 110 73083
R 136	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 137	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 138	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 142	RESISTOR,M.FILM	10	5	CR25	4822 110 73054
R 143	RESISTOR,M.FILM	3,9	5	R25	4822 110 73043
R 144	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 145	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 146	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 147	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 2	POTM,CARB+SW.	10K	20	0.25W	5322 101 44005
R 226	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 227	RESISTOR,M.FILM	909K	0,1		5322 116 51833
R 228	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 229	RESISTOR,M.FILM	111K	0,1		5322 116 51829
R 232	RESISTOR,M.FILM	992K	0,1		5322 116 51834
R 233	RESISTOR,M.FILM	10,1K	0,1		5322 116 51826
R 236	RESISTOR,M.FILM	156	0,1		5322 116 51816
R 237	RESISTOR,M.FILM	437	0,1		5322 116 51818
R 238	RESISTOR,M.FILM	1,11K	0,1		5322 116 51821
R 239	RESISTOR,M.FILM	4,75K	0,1		5322 116 51824

POSNR	DESCRIPTION				ORDERING CODE
R 240	RESISTOR,M.FILM	348	0,1		5322 116 51817
R 241	RESISTOR,M.FILM	898	0,1		5322 116 51819
R 242	RESISTOR,M.FILM	1,89K	0,1		5322 116 51822
R 243	RESISTOR,M.FILM	17,2K	0,1		5322 116 51827
R 244	RESISTOR,M.FILM	4,27K	0,1		5322 116 51823
R 251	RESISTOR,M.FILM	90,9K	0,1		5322 116 51831
R 252	RESISTOR,M.FILM	909K	0,1		5322 116 51833
R 253	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 254	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 255	RESISTOR,M.FILM	51K	5	CR25	4822 110 70153
R 256	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 257	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 258	RESISTOR,M.FILM	5,6K	5	CR25	4822 110 73127
R 259	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 26	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 261	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 262	RESISTOR,M.FILM	4,93K	0,1		5322 116 51825
R 263	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 264	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 265	RESISTOR,M.FILM	12	5	CR25	4822 110 73056
R 266	RESISTOR,M.FILM	75	5	CR25	4822 110 70077
R 267	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 268	RESISTOR,NTC	33	10	0.5W	4822 116 30262
R 27	RESISTOR,M.FILM	900K	0,1		5322 116 51832
R 272	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 276	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 277	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 278	RESISTOR,M.FILM	2K	5	CR25	4822 110 70115
R 28	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 280	RESISTOR,M.FILM	150	5	CR25	4822 110 73085
R 281	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 282	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 283	RESISTOR,CARBON	300	5	CR25	4822 110 60093
R 284	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 286	RESISTOR,M.FILM	120	5	CR25	4822 110 73083
R 287	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 288	RESISTOR,M.FILM	5,6K	5	CR25	4822 110 73127
R 289	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 29	RESISTOR,M.FILM	111K	0,1		5322 116 51829
R 291	RESISTOR,M.FILM	220	5	CR25	4822 110 73089
R 292	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 293	RESISTOR,M.FILM	2K	5	CR25	4822 110 70115
R 294	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 295	RESISTOR,M.FILM	39	5	CR25	4822 110 73069
R 296	RESISTOR,M.FILM	7,5K	5	CR25	4822 110 70131
R 297	RESISTOR,M.FILM	5,36K	0,1		5322 116 51815
R 298	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 299	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 3	POTM,BALANCE	47K +47K	LIN		4822 102 30177
R 300	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 301	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 302	RESISTOR,M.FILM	17,4K	0,1		5322 116 51828
R 303	RESISTOR,M.FILM	510	5	CR25	4822 110 70099
R 306	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 307	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 308	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 309	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 311	POTM,TRIMMING	470	20	0,5W	5322 101 14047
R 312	RESISTOR,M.FILM	220	5	CR25	4822 110 73089
R 314	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 316	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 317	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 318	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 319	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 32	RESISTOR,M.FILM	992K	0,1		5322 116 51834

POSNR	DESCRIPTION				ORDERING CODE
R 321	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 322	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 323	RESISTOR,HT	5,6M	5	VR37	4822 110 42207
R 324	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 326	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 327	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 328	RESISTOR,M.FILM	909K	0,1		5322 116 51833
R 329	RESISTOR,HT	10M	5	VR37	4822 110 42214
R 33	RESISTOR,M.FILM	10,1K	0,1		5322 116 51826
R 331	RESISTOR,M.FILM	510K	5	CR25	4822 110 70179
R 332	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 333	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 334	RESISTOR,M.FILM	120	5	CR25	4822 110 73083
R 336	RESISTOR,CARBON	300	5	CR25	4822 110 60093
R 337	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 338	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 339	RESISTOR,M.FILM	3,9	5	R25	4822 110 73043
R 341	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 342	RESISTOR,M.FILM	10	5	CR25	4822 110 73054
R 345	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 346	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 36	RESISTOR,M.FILM	156	0,1		5322 116 51816
R 37	RESISTOR,M.FILM	437	0,1		5322 116 51818
R 38	RESISTOR,M.FILM	1,11K	0,1		5322 116 51821
R 39	RESISTOR,M.FILM	4,75K	0,1		5322 116 51824
R 4	POTM,CARBON	1K	20	0.1W	4822 101 20455
R 40	RESISTOR,M.FILM	348	0,1		5322 116 51817
R 400	RESISTOR,HT	2,2M	5	VR25	4822 110 72196
R 401	RESISTOR,M.FILM	91K	5	CR37	5322 116 54749
R 402	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 403	RESISTOR,M.FILM	5,11K	1	MR25	5322 116 54595
R 404	RESISTOR,M.FILM	6,49K	1	MR25	5322 116 54603
R 405	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 406	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 407	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 408	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 409	RESISTOR,M.FILM	4,3K	5	CR25	4822 110 70124
R 41	RESISTOR,M.FILM	898	0,1		5322 116 51819
R 410	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 411	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 412	RESISTOR,M.FILM	2,4K	5	CR25	4822 110 70117
R 413	RESISTOR,M.FILM	1,1K	5	CR25	4822 110 70108
R 414	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 415	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 416	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 418	RESISTOR,M.FILM	20K	5	CR25	4822 110 70142
R 419	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 42	RESISTOR,M.FILM	1,89K	0,1		5322 116 51822
R 420	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 421	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 422	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 423	RESISTOR,M.FILM	1,2K	5	CR25	4822 110 73109
R 424	POTM,TRIMMING	2,2K	20	0.05W	4822 100 10029
R 426	RESISTOR,M.FILM	820	5	CR25	4822 110 73105
R 427	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 428	RESISTOR,M.FILM	27K	5	CR25	4822 110 73145
R 429	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 43	RESISTOR,M.FILM	17,2K	0,1		5322 116 51827
R 431	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 432	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 433	RESISTOR,M.FILM	22K	5	CR25	4822 110 73143
R 434	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 436	RESISTOR,M.FILM	22K	5	CR25	4822 110 73143
R 44	RESISTOR,M.FILM	4,27K	0,1		5322 116 51823
R 440	RESISTOR,M.FILM	1	5	CR25	4822 110 73027

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R 443	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 447	RESISTOR,M.FILM	1,8K	5	CR25	4822 110 73114
R 448	RESISTOR,M.FILM	430	5	CR25	4822 110 70097
R 449	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 5	POTM,CARBON	1K	20	0.1W	4822 101 20455
R 501	RESISTOR,M.FILM	121	1	MR25	5322 116 54426
R 502	RESISTOR,M.FILM	3,32K	1	MR25	5322 116 54005
R 503	RESISTOR,CARBON	160	5	CR25	4822 110 60086
R 504	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 506	RESISTOR,M.FILM	1,21K	1	MR25	5322 116 54557
R 507	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 508	RESISTOR,M.FILM	240	5	CR25	4822 110 70091
R 509	RESISTOR,M.FILM	681	1	MR25	4822 116 51233
R 51	RESISTOR,M.FILM	90,9K	0,1		5322 116 51831
R 511	RESISTOR,M.FILM	6,19K	1	MR25	5322 116 55426
R 512	RESISTOR,M.FILM	1,2K	5	CR25	4822 110 73109
R 513	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 514	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 516	RESISTOR,M.FILM	3,01K	1	MR25	4822 116 51246
R 517	RESISTOR,M.FILM	13,3K	1	MR25	5322 116 55276
R 518	RESISTOR,M.FILM	6,8K	5	CR25	4822 110 73129
R 519	RESISTOR,M.FILM	68K	5	CR25	4822 110 73156
R 52	RESISTOR,M.FILM	909K	0,1		5322 116 51833
R 521	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 522	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 524	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 526	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 527	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 528	RESISTOR,CARBON	75K	5	CR25	4822 110 60157
R 529	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 53	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 530	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 531	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 532	RESISTOR,NTC	1,3K	20	1W	4822 116 30018
R 533	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 534	POTM,TRIMMING	2,2K	20	0.05W	4822 100 10029
R 536	RESISTOR,M.FILM	5,1K	5	CR25	4822 110 70126
R 537	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 538	RESISTOR,M.FILM	6,2K	5	CR25	4822 110 70128
R 539	POTM,TRIMMING	22K	20	0.05W	4822 100 10051
R 54	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 541	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 542	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 543	RESISTOR,M.FILM	180	5	CR25	4822 110 73087
R 544	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 547	RESISTOR,M.FILM	560	5	CR25	4822 110 73101
R 549	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 55	RESISTOR,M.FILM	51K	5	CR25	4822 110 70153
R 551	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 552	RESISTOR,M.FILM	6,8K	5	CR25	4822 110 73129
R 553	POTM,TRIMMING	1K	20	0.05W	4822 100 10037
R 554	RESISTOR,M.FILM	12K	5	CR25	4822 110 73136
R 556	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 557	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 558	RESISTOR,CARBON	1K	5	CR37	4822 110 53107
R 559	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 56	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 561	RESISTOR,M.FILM	22	5	CR25	4822 110 73063
R 562	RESISTOR,M.FILM	22	5	CR25	4822 110 73063
R 563	RESISTOR,M.FILM	22	5	CR25	4822 110 73063
R 565	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 566	RESISTOR,M.FILM	576K	1	MR30	5322 116 54278
R 567	RESISTOR,M.FILM	226K	1	MR25	5322 116 54729
R 568	RESISTOR,M.FILM	115K	1	MR25	5322 116 54279
R 569	RESISTOR,M.FILM	56,2K	1	MR25	4822 116 51264

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R 57	RESISTOR,M.FILM	680	5 CR25	4822 110 73103
R 570	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 571	RESISTOR,M.FILM	22,6K	1 MR25	5322 116 50481
R 572	RESISTOR,M.FILM	11,3K	1 MR25	5322 116 50668
R 573	RESISTOR,M.FILM	5,62K	1 MR25	4822 116 51281
R 574	RESISTOR,M.FILM	2,21K	1 MR25	4822 116 51245
R 576	RESISTOR,M.FILM	1,1K	1 MR25	4822 116 51236
R 58	RESISTOR,M.FILM	5,6K	5 CR25	4822 110 73127
R 59	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 6	POTM,CARBON	22K	20 0,1W	4822 101 20417
R 60	RESISTOR,M.FILM	6,8K	5 CR25	4822 110 73129
R 601	POTM,TRIMMING	1K	20 0.05W	4822 100 10037
R 602	RESISTOR,M.FILM	1,5K	5 CR25	4822 110 73112
R 603	RESISTOR,M.FILM	100	5 CR25	4822 110 73081
R 604	RESISTOR,M.FILM	3K	5 CR25	4822 110 70119
R 606	RESISTOR,M.FILM	8,2K	5 CR25	4822 110 73132
R 607	RESISTOR,M.FILM	12K	5 CR25	4822 110 73136
R 609	RESISTOR,M.FILM	68K	5 CR25	4822 110 73156
R 61	RESISTOR,M.FILM	8,2K	5 CR25	4822 110 73132
R 610	RESISTOR,M.FILM	2,2K	5 CR25	4822 110 73116
R 611	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 612	RESISTOR,M.FILM	910	5 CR25	4822 110 70106
R 613	RESISTOR,M.FILM	5,6K	5 CR25	4822 110 73127
R 614	RESISTOR,M.FILM	1,8K	5 CR25	4822 110 73114
R 615	RESISTOR,M.FILM	3K	5 CR25	4822 110 70119
R 616	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 617	POTM,TRIMMING	470	20 0.05W	4822 100 10038
R 618	POTM,TRIMMING	10K	20 0.05W	4822 100 10035
R 619	RESISTOR,M.FILM	68K	5 CR25	4822 110 73156
R 62	RESISTOR,M.FILM	4,93K	0,1	5322 116 51825
R 621	RESISTOR,M.FILM	4,7K	5 CR25	4822 110 73125
R 622	RESISTOR,M.FILM	6,8K	5 CR25	4822 110 73129
R 623	RESISTOR,M.FILM	4,7K	5 CR25	4822 110 73125
R 624	RESISTOR,M.FILM	1,8K	5 CR25	4822 110 73114
R 626	RESISTOR,M.FILM	10K	5 CR25	4822 110 73134
R 627	RESISTOR,CARBON	47K	5 CR37	4822 110 53152
R 628	RESISTOR,CARBON	47K	5 CR37	4822 110 53152
R 63	RESISTOR,M.FILM	330	5 CR25	4822 110 73094
R 631	RESISTOR,M.FILM	820	5 CR25	4822 110 73105
R 632	RESISTOR,M.FILM	22	5 CR25	4822 110 73063
R 633	RESISTOR,CARBON	47K	5 CR37	4822 110 53152
R 636	RESISTOR,M.FILM	820	5 CR25	4822 110 73105
R 637	RESISTOR,CARBON	47K	5 CR37	4822 110 53152
R 638	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 639	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 64	POTM,TRIMMING	470	20 0.05W	4822 100 10038
R 65	RESISTOR,M.FILM	12	5 CR25	4822 110 73056
R 66	RESISTOR,M.FILM	75	5 CR25	4822 110 70077
R 67	RESISTOR,M.FILM	8,2K	5 CR25	4822 110 73132
R 68	RESISTOR,NTC	33	10 0.5W	4822 116 30262
R 69	RESISTOR,M.FILM	100	5 CR25	4822 110 73081
R 7	POTM,CARBON	22K	20 0,1W	4822 101 20417
R 701	RESISTOR,M.FILM	8,2K	5 CR25	4822 110 73132
R 704	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 705	RESISTOR,M.FILM	47	5 CR25	4822 110 73072
R 706	RESISTOR,CARBON	1,6K	5 CR25	4822 110 60113
R 707	RESISTOR,M.FILM	470	5 CR25	4822 110 73098
R 708	RESISTOR,M.FILM	10K	5 CR25	4822 110 73134
R 709	RESISTOR,M.FILM	68K	5 CR25	4822 110 73156
R 71	RESISTOR,M.FILM	10K	5 CR25	4822 110 73134
R 710	RESISTOR,M.FILM	1K	5 CR25	4822 110 73107
R 711	POTM,TRIMMING	2,2K	20 0.05W	4822 100 10029
R 712	RESISTOR,M.FILM	1,1K	5 CR25	4822 110 70108
R 713	RESISTOR,M.FILM	1M	1 MR25	5322 116 55535
R 714	RESISTOR,M.FILM	1M	1 MR25	5322 116 55535

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R 715	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 716	RESISTOR,M.FILM	4,7K	5	CR25	4822 110 73125
R 717	RESISTOR,M.FILM	33K	5	CR25	4822 110 73147
R 718	RESISTOR,M.FILM	110K	5	CR25	4822 110 70162
R 719	RESISTOR,M.FILM	68K	5	CR25	4822 110 73156
R 72	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 720	RESISTOR,M.FILM	82K	5	CR25	4822 110 73158
R 722	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 73	RESISTOR,M.FILM	150	5	CR25	4822 110 73085
R 74	RESISTOR,M.FILM	2K	5	CR25	4822 110 70115
R 75	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 750	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 751	RESISTOR,M.FILM	3,9K	5	CR25	4822 110 73123
R 752	RESISTOR,M.FILM	1,8K	5	CR25	4822 110 73114
R 753	RESISTOR,M.FILM	8,2K	5	CR25	4822 110 73132
R 754	RESISTOR,M.FILM	820K	5	CR25	4822 110 73185
R 756	RESISTOR,M.FILM	560	5	CR25	4822 110 73101
R 757	RESISTOR,M.FILM	3,9K	5	CR25	4822 110 73123
R 758	RESISTOR,M.FILM	270	5	CR25	4822 110 73092
R 759	RESISTOR,M.FILM	11K	1	MR25	5322 116 54623
R 76	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 761	POTM,TRIMMING	1K	20	0.05W	4822 100 10037
R 762	RESISTOR,M.FILM	1,1K	1	MR25	4822 116 51236
R 763	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 764	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 77	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 78	RESISTOR,M.FILM	2,2K	5	CR25	4822 110 73116
R 8	POTM,CARB+SW.	22K	20	0.25W	4822 101 40061
R 800	RESISTOR,CARBON	240K	5	CR25	4822 110 60171
R 801	POTM,TRIMMING	1M	20	0.05W	4822 100 10089
R 802	RESISTOR,M.FILM	1K	5	CR25	4822 110 73107
R 803	RESISTOR,M.FILM	1,8M	5	VR68	4822 116 51329
R 805	RESISTOR,CARBON	75K	5	CR25	4822 110 60157
R 806	RESISTOR,M.FILM	470K	5	CR25	4822 110 73178
R 807	RESISTOR,HT	1,5M	5	VR68	4822 116 60045
R 809	POTM,TRIMMING	470K	20	0.05W	4822 100 10107
R 81	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 810	RESISTOR,CARBON	820K	5	CR37	4822 110 53185
R 811	RESISTOR,M.FILM	100K	5	CR25	4822 110 73161
R 812	POTM,TRIMMING	470K	20	0.05W	4822 100 10107
R 813	POTM,CARBON	22K	20	0.1W	5322 101 24115
R 815	RESISTOR,M.FILM	1	5	CR25	4822 110 73027
R 817	RESISTOR,M.FILM	22K	5	CR25	4822 110 73143
R 818	RESISTOR,M.FILM	390	5	CR25	4822 110 73096
R 819	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 82	RESISTOR,CARBON	6,8K	5	CR37	4822 110 53129
R 820	RESISTOR,M.FILM	560	5	CR25	4822 110 73101
R 821	RESISTOR,M.FILM	47K	5	CR25	4822 110 73152
R 822	RESISTOR,M.FILM	820	5	CR25	4822 110 73105
R 823	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 824	RESISTOR,M.FILM	820	5	CR25	4822 110 73105
R 825	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 826	RESISTOR,M.FILM	1,5K	5	CR25	4822 110 73112
R 827	RESISTOR,M.FILM	10	5	CR25	4822 110 73054
R 828	RESISTOR,HT	6,49M	1	VR68	5322 116 60125
R 829	RESISTOR,M.FILM	24K	5	CR25	4822 110 70144
R 83	RESISTOR,M.FILM	330	5	CR25	4822 110 73094
R 830	RESISTOR,M.FILM	10K	5	CR25	4822 110 73134
R 831	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 832	RESISTOR,M.FILM	2K	5	CR25	4822 110 70115
R 833	RESISTOR,M.FILM	3,32K	1	MR25	5322 116 54005
R 834	POTM,TRIMMING	22K	20	0.05W	4822 100 10051
R 836	RESISTOR,M.FILM	3,32K	1	MR25	5322 116 54005
R 837	RESISTOR,M.FILM	3,32K	1	MR25	5322 116 54005
R 838	POTM,TRIMMING	22K	20	0.05W	4822 100 10051

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R 839	RESISTOR,M.FILM	3,32K	1	MR25	5322 116 54005
R 84	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 841	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 842	RESISTOR,M.FILM	51,1K	1	MR25	5322 116 50672
R 843	RESISTOR,M.FILM	220K	5	CR25	4822 110 73169
R 844	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 846	RESISTOR,M.FILM	100	1	MR25	5322 116 55549
R 847	POTM,TRIMMING	4,7K	20	0.05W	4822 100 10036
R 848	POTM,TRIMMING	1M	20	0.05W	4822 100 10089
R 849	POTM,TRIMMING	1M	20	0.05W	4822 100 10089
R 851	RESISTOR,HT	6,49M	1	VR68	5322 116 60125
R 852	RESISTOR,HT	1M	5	VR37	4822 110 42187
R 853	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 854	RESISTOR,M.FILM	10K	1	MR25	4822 116 51253
R 856	RESISTOR,M.FILM	383	1	MR25	5322 116 55368
R 857	RESISTOR,M.FILM	383	1	MR25	5322 116 55368
R 859	RESISTOR,M.FILM	27,4K	1	MR25	5322 116 50559
R 86	RESISTOR,M.FILM	120	5	CR25	4822 110 73083
R 861	RESISTOR,M.FILM	100K	1	MR25	4822 116 51268
R 87	RESISTOR,CARBON	5,6K	5	CR37	4822 110 53127
R 88	RESISTOR,M.FILM	5,6K	5	CR25	4822 110 73127
R 89	RESISTOR,M.FILM	680	5	CR25	4822 110 73103
R 9	POTM,CARBON	4K7			5322 101 24032
R 901	RESISTOR,M.FILM	1M	5	CR25	4822 110 73187
R 902	RESISTOR,M.FILM	820	5	CR25	4822 110 73105
R 903	RESISTOR,M.FILM	402	1	MR25	5322 116 54519
R 904	RESISTOR,M.FILM	1,27K	1	MR25	5322 116 50555
R 906	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 908	RESISTOR,M.FILM	820	5	CR25	4822 110 73105
R 909	RESISTOR,M.FILM	470	5	CR25	4822 110 73098
R 91	RESISTOR,M.FILM	220	5	CR25	4822 110 73089
R 911	RESISTOR,M.FILM	825	1	MR25	5322 116 54541
R 912	RESISTOR,M.FILM	3,6K	5	CR25	4822 110 70122
R 913	RESISTOR,CARBON	300	5	CR25	4822 110 60093
R 914	RESISTOR,M.FILM	13K	5	CR25	4822 110 70137
R 916	RESISTOR,M.FILM	140	1	MR25	5322 116 55568
R 917	RESISTOR,M.FILM	140	1	MR25	5322 116 55568
R 918	RESISTOR,M.FILM	3,65K	1	MR25	5322 116 54587
R 919	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 92	RESISTOR,M.FILM	3,3K	5	CR25	4822 110 73121
R 920	RESISTOR,M.FILM	348	1	MR25	5322 116 54515
R 921	RESISTOR,M.FILM	3,9K	5	CR25	4822 110 73123
R 922	RESISTOR,M.FILM	1,2K	5	CR25	4822 110 73109
R 923	RESISTOR,M.FILM	3,48K	1	MR25	5322 116 55367
R 924	RESISTOR,M.FILM	1,1K	1	MR25	4822 116 51236
R 93	RESISTOR,M.FILM	2K	5	CR25	4822 110 70115
R 94	POTM,TRIMMING	470	20	0.05W	4822 100 10038
R 95	RESISTOR,M.FILM	100	5	CR25	4822 110 73081
R 96	RESISTOR,M.FILM	7,5K	5	CR25	4822 110 70131
R 97	RESISTOR,M.FILM	5,36K	0,1		5322 116 51815
R 98	RESISTOR,M.FILM	47	5	CR25	4822 110 73072
R 99	POTM,TRIMMING	470	20	0.05W	4822 100 10038

3.6.2.3. Diodes

POSNR	DESCRIPTION			ORDERING CODE
GR1001	DIODE,REFERENCE	BZX79-B4V7	PH	4822 130 34174
GR1002	DIODE,REFERENCE	BZX79-B4V7	PH	4822 130 34174
GR1011	DIODE	BAW62	PH	4822 130 30613
GR1012	DIODE	BAS11	PH	4822 130 41273

POSNR	DESCRIPTION			ORDERING CODE
GR1013	DIODE	BAW62	PH	4822 130 30613
GR1014	DIODE	BAS11	PH	4822 130 41273
GR1015	DIODE	BAW62	PH	4822 130 30613
GR1016	DIODE	BYV96D	PH	4822 130 31348
GR1017	DIODE	BAW62	PH	4822 130 30613
GR1018	DIODE,REFERENCE	BZX79-C16	PH	4822 130 34268
GR1019	DIODE	BAW62	PH	4822 130 30613
GR1020	DIODE	BAW62	PH	4822 130 30613
GR1021	DIODE,REFERENCE	BZX79-C4V7	PH	4822 130 34174
GR1024	DIODE	BAW62	PH	4822 130 30613
GR1026	DIODE	BAW62	PH	4822 130 30613
GR1027	DIODE	BAW62	PH	4822 130 30613
GR1028	DIODE	BAW62	PH	4822 130 30613
GR1033	DIODE	BAW62	PH	4822 130 30613
GR1034	DIODE,REFERENCE	BZX79-C4V7	PH	4822 130 34174
GR135	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR253	DIODE	BAV45	PH	5322 130 34037
GR254	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR257	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
GR285	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR335	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR401	DIODE	BAW62	PH	4822 130 30613
GR402	DIODE	BAW62	PH	4822 130 30613
GR403	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR404	DIODE	AAZ18	PH	4822 130 30084
GR406	DIODE	AAZ18	PH	4822 130 30084
GR408	DIODE	BZX79-C12	PH	4822 130 34197
GR409	DIODE	BAW62	PH	4822 130 30613
GR501	DIODE	AAZ18	PH	4822 130 30084
GR502	DIODE	BAW62	PH	4822 130 30613
GR503	DIODE	BAW62	PH	4822 130 30613
GR504	DIODE	BAW62	PH	4822 130 30613
GR506	DIODE	BAW62	PH	4822 130 30613
GR53	DIODE	BAV45	PH	5322 130 34037
GR54	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR56	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
GR57	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
GR58	DIODE,REFERENCE	BZX79-C6V2	PH	4822 130 34167
GR629	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR634	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR702	DIODE	BAV21	PH	4822 130 30842
GR703	DIODE	BAW62	PH	4822 130 30613
GR721	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR751	DIODE,REFERENCE	BZX79-B6V2	PH	4822 130 34167
GR801	DIODE,REFERENCE	BZX79-C18	PH	4822 130 31024
GR802	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR803	DIODE	BY225-200	PH	4822 130 50312
GR808	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR809	DIODE,REFERENCE	BZX75-C2V1	PH	4822 130 34049
GR810	DIODE	BAX12A	PH	5322 130 34605
GR811	DIODE,REFERENCE	BZX79-C5V6	PH	4822 130 34173
GR812	DIODE	BAX12A	PH	5322 130 34605
GR813	DIODE	BAX12A	PH	5322 130 34605
GR814	DIODE	BY509	PH	4822 130 41485
GR816	DIODE	BY509	PH	4822 130 41485
GR817	DIODE	BY509	PH	4822 130 41485
GR818	DIODE	BYV96D	PH	4822 130 31348
GR819	DIODE	BAS11	PH	4822 130 41273
GR820	DIODE	BYV96D	PH	4822 130 31348
GR821	DIODE	BAX12A	PH	5322 130 34605
GR822	DIODE	BAX12A	PH	5322 130 34605
GR823	DIODE	BAX12A	PH	5322 130 34605
GR824	DIODE	BAX12A	PH	5322 130 34605
GR826	DIODE	BAX12A	PH	5322 130 34605
GR827	DIODE	BAX12A	PH	5322 130 34605

POSNR	DESCRIPTION			ORDERING CODE
GR828	DIODE	BAS11	PH	4822 130 41273
GR829	DIODE	BYV96D	PH	4822 130 31348
GR831	DIODE	BYX71-350R	PH	4822 130 34275
GR832	DIODE	BY509	PH	4822 130 41485
GR833	DIODE	BY509	PH	4822 130 41485
GR834	DIODE	BYV96D	PH	4822 130 31348
GR836	DIODE,REFERENCE	BZX79-B6V2	PH	4822 130 34167
GR837	DIODE,REFERENCE	BZX79-B6V2	PH	4822 130 34167
GR838	DIODE	BAW62	PH	4822 130 30613
GR839	DIODE	BAW62	PH	4822 130 30613
GR85	DIODE,REFERENCE	BZX75-C1V4	PH	4822 130 34047
GR901	DIODE,REFERENCE	BZX79-B4V7	PH	4822 130 34174
GR902	DIODE,REFERENCE	BZX79-B4V7	PH	4822 130 34174

3.6.2.4. Transistors

POSNR	DESCRIPTION			ORDERING CODE
TS1001	TRANSISTOR	BC549C	PH	4822 130 44246
TS1002	TRANSISTOR	BF494	PH	4822 130 44195
TS1003	TRANSISTOR	BF494	PH	4822 130 44195
TS1004	TRANSISTOR	BC549	PH	4822 130 40964
TS1005	TRANSISTOR	BC548C	PH	4822 130 44196
TS1006	TRANSISTOR	BC549C	PH	4822 130 44246
TS1011	TRANSISTOR	BC549C	PH	4822 130 44246
TS1012	TRANSISTOR	BC549C	PH	4822 130 44246
TS1013	TRANSISTOR	BC556	PH	4822 130 40989
TS1014	TRANSISTOR	BSS78	MO	5322 130 42086
TS1015	TRANSISTOR	BSS78	MO	5322 130 42086
TS1016	TRANSISTOR	BC557	PH	4822 130 44256
TS1017	TRANSISTOR	BC549C	PH	4822 130 44246
TS1018	TRANSISTOR	BSS38	PH	4822 130 40968
TS1019	TRANSISTOR	BSS38	PH	4822 130 40968
TS1021	TRANSISTOR	BC559	PH	4822 130 40963
TS1022	TRANSISTOR	BC559	PH	4822 130 40963
TS1023	TRANSISTOR	BC547	PH	4822 130 44257
TS1024	TRANSISTOR	BC549	PH	4822 130 40964
TS1026	TRANSISTOR	BC548C	PH	4822 130 44196
TS1028	TRANSISTOR	BC559	PH	4822 130 40963
TS1029	TRANSISTOR	BSS38	PH	4822 130 40968
TS1031	TRANSISTOR	BSS38	PH	4822 130 40968
TS251	TRIAC	BFW11	PH	4822 130 40408
TS252	TRANSISTOR	BF494	PH	4822 130 44195
TS253	TRANSISTOR	BC557	PH	4822 130 44256
TS254	TRANSISTOR	BF199	PH	4822 130 44154
TS257	TRANSISTOR	BF199	PH	4822 130 44154
TS258	TRANSISTOR	BF199	PH	4822 130 44154
TS259	TRANSISTOR	BF199	PH	4822 130 44154
TS261	TRANSISTOR	BF494	PH	4822 130 44195
TS262	TRIAC	BFW11	PH	4822 130 40408
TS263	TRANSISTOR	BCY71	PH	5322 130 40373
TS264	TRANSISTOR	BCY70	PH	5322 130 40324
TS266	TRANSISTOR	BC549	PH	4822 130 40964
TS267	TRANSISTOR	BC549	PH	4822 130 40964
TS268	TRANSISTOR	BF199	PH	4822 130 44154
TS269	TRANSISTOR	BF199	PH	4822 130 44154
TS271	TRANSISTOR	BC109C	PH	4822 130 44246
TS272	TRANSISTOR	BC109C	PH	4822 130 44246
TS273	TRANSISTOR	BF199	PH	4822 130 44154
TS274	TRANSISTOR	BF199	PH	4822 130 44154

POSNR	DESCRIPTION			ORDERING CODE
TS276	TRANSISTOR	BF199	PH	4822 130 44154
TS400	TRANSISTOR	BC559	PH	4822 130 40963
TS401	TRANSISTOR	BC559	PH	4822 130 40963
TS402	TRANSISTOR	BF494	PH	4822 130 44195
TS403	TRANSISTOR	BC549C	PH	4822 130 44246
TS404	TRANSISTOR	BC549C	PH	4822 130 44246
TS406	TRANSISTOR	BC549	PH	4822 130 40964
TS408	TRANSISTOR	BC559	PH	4822 130 40963
TS501	TRANSISTOR	BF494	PH	4822 130 44195
TS502	TRANSISTOR	BF494	PH	4822 130 44195
TS503	TRANSISTOR	BC549C	PH	4822 130 44246
TS504	TRANSISTOR	BC549C	PH	4822 130 44246
TS506	TRANSISTOR	BC557	PH	4822 130 44256
TS508	TRANSISTOR	BC547	PH	4822 130 44257
TS509	TRANSISTOR	BSX20	PH	4822 130 41705
TS51	TRIAC	BFW11	PH	4822 130 40408
TS511	TRANSISTOR	BC559	PH	4822 130 40963
TS512	TRANSISTOR	BC549	PH	4822 130 40964
TS513	TRANSISTOR	BC549	PH	4822 130 40964
TS516	TRANSISTOR	BC547	PH	4822 130 44257
TS52	TRANSISTOR	BF494	PH	4822 130 44195
TS53	TRANSISTOR	BC557	PH	4822 130 44256
TS54	TRANSISTOR	BF199	PH	4822 130 44154
TS56	TRANSISTOR	BC547	PH	4822 130 44257
TS57	TRANSISTOR	BF199	PH	4822 130 44154
TS58	TRANSISTOR	BF199	PH	4822 130 44154
TS59	TRANSISTOR	BF199	PH	4822 130 44154
TS602	TRANSISTOR	BF494	PH	4822 130 44195
TS603	TRANSISTOR	BF494	PH	4822 130 44195
TS604	TRANSISTOR	BF494	PH	4822 130 44195
TS606	TRANSISTOR	BC547	PH	4822 130 44257
TS607	TRANSISTOR	BSS78	MO	5322 130 42086
TS608	TRANSISTOR	BSS78	MO	5322 130 42086
TS609	TRANSISTOR	BSS78	MO	5322 130 42086
TS61	TRANSISTOR	BF494	PH	4822 130 44195
TS611	TRANSISTOR	BSS78	MO	5322 130 42086
TS62	TRIAC	BFW11	PH	4822 130 40408
TS63	TRANSISTOR	BCY71	PH	5322 130 40373
TS64	TRANSISTOR	BCY70	PH	5322 130 40324
TS66	TRANSISTOR	BC549	PH	4822 130 40964
TS67	TRANSISTOR	BC549	PH	4822 130 40964
TS68	TRANSISTOR	BF199	PH	4822 130 44154
TS69	TRANSISTOR	BF199	PH	4822 130 44154
TS702	TRANSISTOR	BC557	PH	4822 130 44256
TS703	TRANSISTOR	BSS38	PH	4822 130 40968
TS704	TRANSISTOR	BF199	PH	4822 130 44154
TS706	TRANSISTOR	BF199	PH	4822 130 44154
TS71	TRANSISTOR	BC109C	PH	4822 130 44246 ~ BCF49C
TS72	TRANSISTOR	BC109C	PH	4822 130 44246
TS73	TRANSISTOR	BF199	PH	4822 130 44154
TS74	TRANSISTOR	BF199	PH	4822 130 44154
TS75	TRANSISTOR	BC559	PH	4822 130 40963
TS750	TRANSISTOR	BF494	PH	4822 130 44195
TS751	TRANSISTOR	BF494	PH	4822 130 44195
TS76	TRANSISTOR	BF199	PH	4822 130 44154
TS800	THYRISTOR	BSS68	PH	5322 130 44247
TS801	TRANSISTOR	BSS78	MO	5322 130 42086
TS803	TRANSISTOR	BC557	PH	4822 130 44256
TS804	TRANSISTOR	BC547	PH	4822 130 44257
TS806	TRANSISTOR	BD237	PH	4822 130 44235
TS807	TRANSISTOR	BD237	PH	4822 130 44235
TS808	TRANSISTOR	BC547	PH	4822 130 44257
TS809	TRANSISTOR	BC557	PH	4822 130 44256
TS811	TRANSISTOR	BC557	PH	4822 130 44256
TS812	TRANSISTOR	BC547	PH	4822 130 44257

POSNR	DESCRIPTION			ORDERING CODE
TS813	TRANSISTOR	BC557	PH	4822 130 44256
TS814	TRANSISTOR	BC557	PH	4822 130 44256
TS816	TRANSISTOR	BC547	PH	4822 130 44257
TS901	TRANSISTOR	BC549C	PH	4822 130 44246
TS902	TRANSISTOR	BF494	PH	4822 130 44195
TS903	TRANSISTOR	BF494	PH	4822 130 44195
TS904	TRANSISTOR	BC549	PH	4822 130 40964
TS905	TRANSISTOR	BC548C	PH	4822 130 44196
TS906	TRANSISTOR	BC549C	PH	4822 130 44246

3.6.2.5. Integrated circuits

IC1001	INTEGR.CIRCUIT	TCA220	PH	5322 209 84386
IC1002	INTEGR.CIRCUIT	N7426N	SC	5322 209 84512
IC1003	INTEGR.CIRCUIT	N7426N	SC	5322 209 84512

3.6.2.6. Miscellaneous

L 401	COIL	COIL	68 UH	5322 158 10308
L 800	COIL		4.7UH	5322 158 10276
L 801	COIL	COIL		5322 156 34009
L 802	TRANSF,PULS			5322 142 64028
L 803	COIL	CHOKE		4822 157 50308
L 804	COIL	CHOKE		4822 157 50308
L 805	COIL	COIL	68 UH	5322 158 10308
L 806	COIL	CHOKE		4822 157 50308

3.6.3. PARTS LIST OF PROBE SETS

3.6.3.1. Parts of attenuator probe sets PM 9326 and PM 9327 (Fig. 3.24)

Item	*Qty*	*Ordering number*	*Description*
1	1	5322 320 10042	Probe cable 2 m for PM 9327
1	1	5322 321 20087	Probe cable 1.15 m for PM 9326
2	1	5322 321 20096	Earth lead 15 cm
3	1	5322 321 20134	Earth lead 30 cm
4	1	5322 266 20015	Measuring probe 1:1 (black)
5	1	5322 268 10029	Test pin
6	1	5322 268 10039	Test hook
7	1	5322 210 70044	Attenuator probe 1:10 (grey)
8	1	5322 264 20016	Test clip
	1	5322 111 20155	Resistor

3.6.3.2. Parts of attenuator probe sets PM 9336 and PM 9336L (Fig. 3.26)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 320 14004	Cable assembly PM 9336 (1,5 m)
1	1	5322 320 14013	Cable assembly PM 9336L (2,5 m)
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 20024	Test hook
4	1	5322 264 20028	Test hook sleeve
5	1	5322 532 60535	Protective cap
6	1	5322 256 94034	Probe holder
7	1	5322 268 14017	Probe tip
8	1	5322 321 20223	Earthing cord
9	1	5322 600 34002	Box

3.6.3.3. Parts of probe set PM 9335 (Fig. 3.28)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 264 20024	Test-hook
2	1	5322 264 20028	Test-hook sleeve
3	1	5322 268 14017	Probe tip
4	1	5322 532 60535	Protective cap
5	1	5322 321 20223	Earth lead
6	1	5322 265 94034	Probe holder
7	1	5322 320 14005	Probe assembly
	1	5322 600 34002	Box

3.6.3.4. Parts of 2 kV probe set PM 9358 (Fig. 3.29.)

Item	*Qty*	*Order number*	*Description*
1	1	5322 320 14004	Calbe assembly
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 24008	Test hook
4	1	5322 264 24009	Test hook sleeve
5	1	5322 462 74001	Protective cap
6	1	5322 462 54075	Insulating cap
7	1	5322 265 94034	Probe holder
8	1	5322 264 24011	Test pin
9	1	5322 321 20223	Earthing cord
	1	5322 600 14004	Box

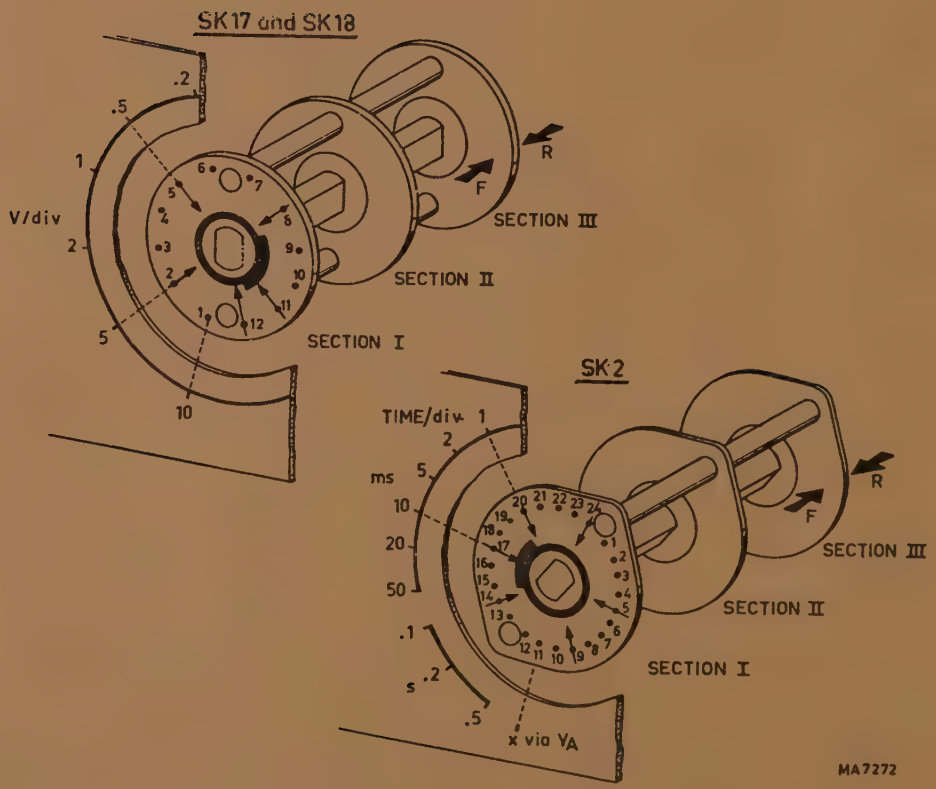


Fig. 3.43. Lay-out of the AMPL. and TIME/div switches

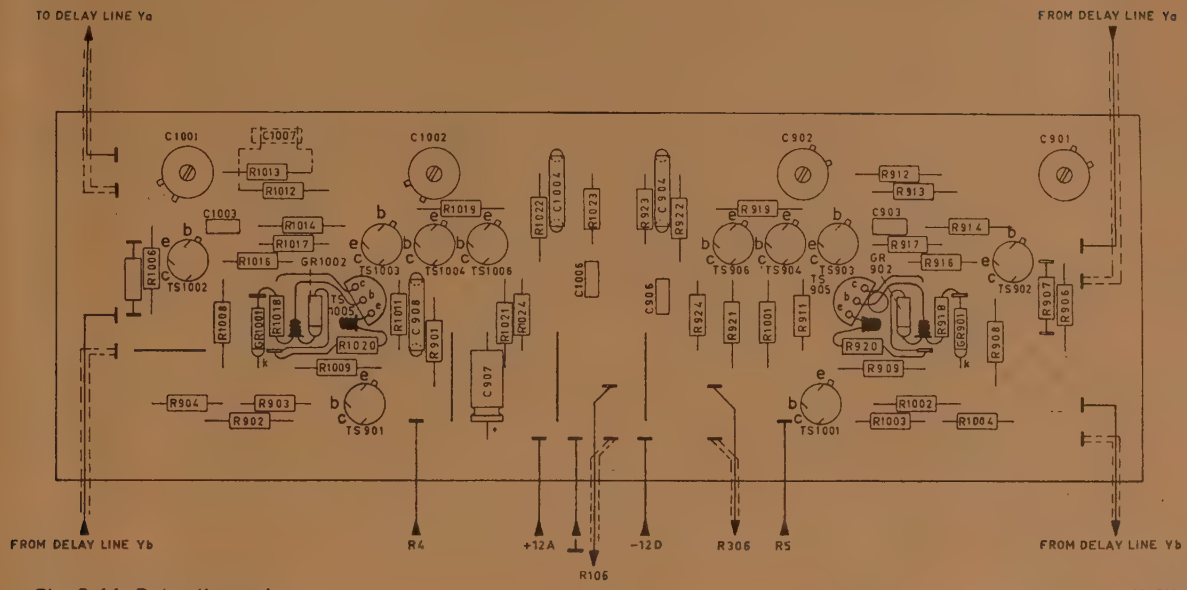


Fig. 3.44. Delay line unit

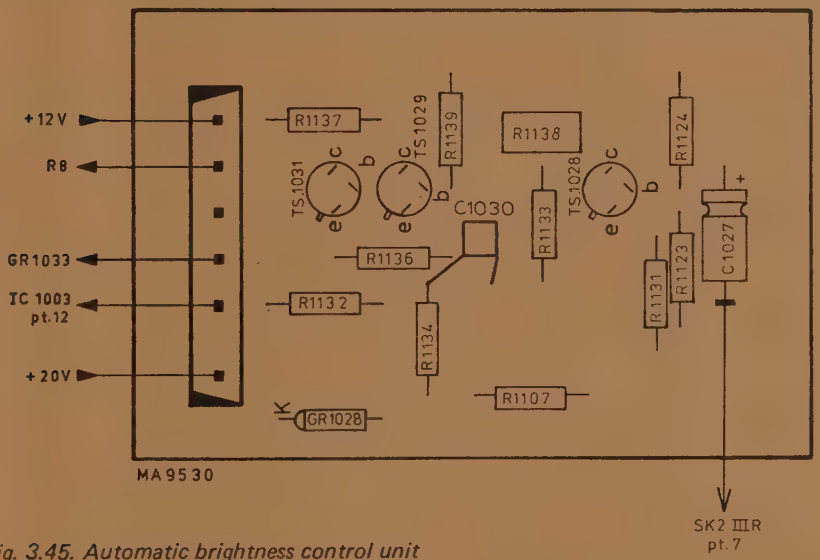


Fig. 3.45. Automatic brightness control unit

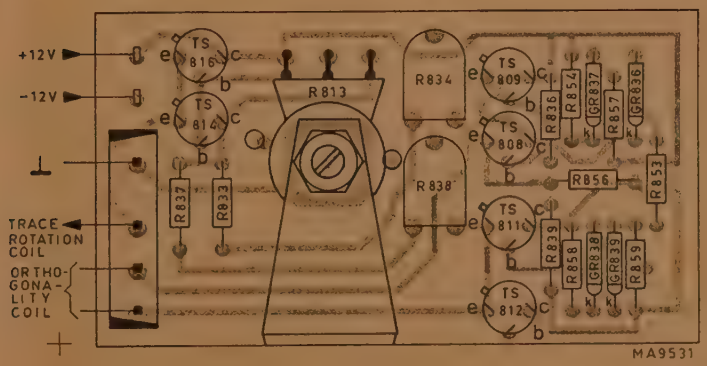


Fig. 3.46. C.R.T. adjustment unit

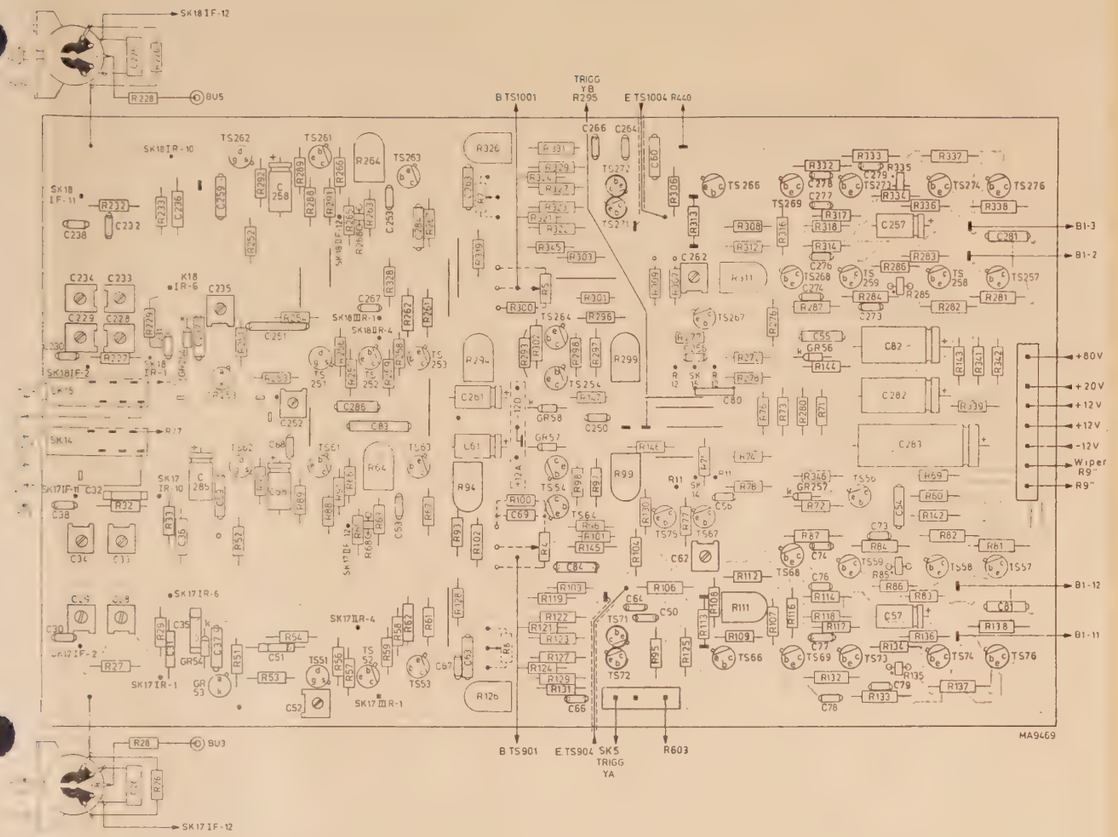
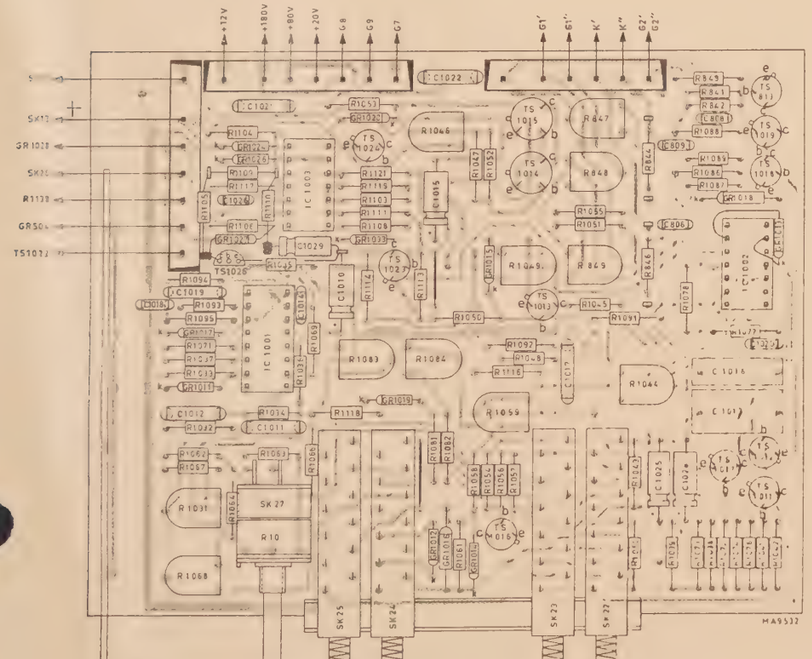


Fig. 3.47. A and B vertical amplifier unit



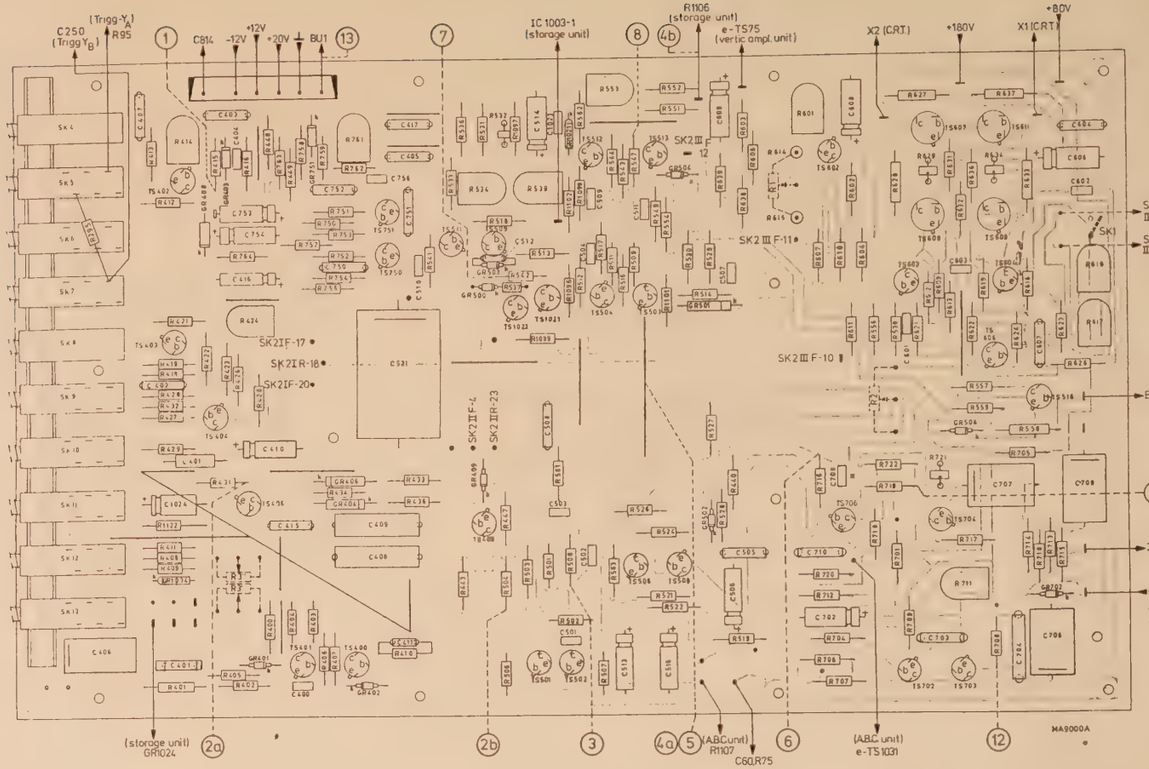
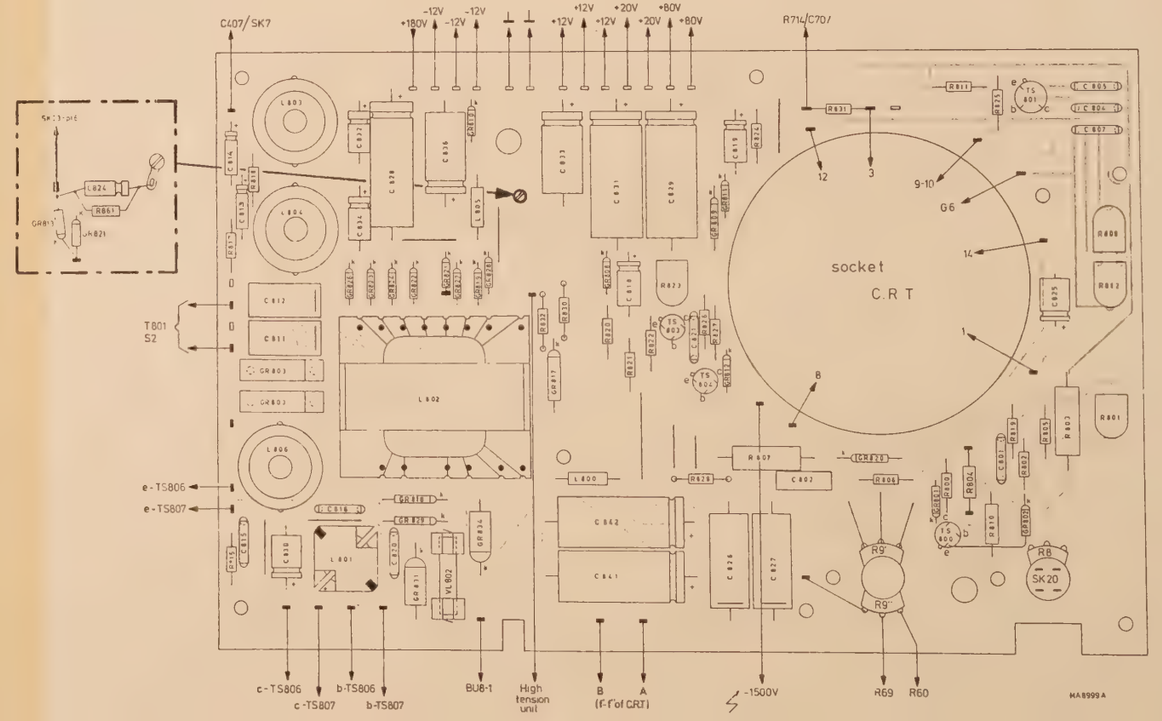


Fig. 3.49. Time-base unit



AMPL. SWITCH Y_A (SK17)

TIME/div SWITCH (SK2)

AMPL. SWITCH Y_B (SK18)

LOCATION OF COMPONENTS

Items 25....399 on A and B vertical amplifier unit
Items 400....799 on Time-base unit
Items 800....850 on Power supply unit and C.R.T. adjustment unit. (except TS813)
Items 900....1025 on Delay line unit
Circuits formed by TS808,809,811,812,814,816 on CRT adjustment unit
Circuits formed by IC1001,1002,1003 and TS813,1011,1012,1013,1014,1015,1016,1017,1018,1019,1023,1024,1026 on storage unit

Circuits formed by TS1028, 1029, 1031 on brightness control unit
Items R1096, 1097, 1098, 1099, 1101, 1102, C1023, GR1021, TS1021, 1022 are located on the time-base unit

PM3234

TABEL 801

COIL	S1	S1'	S1''	S2
CONNECTIONS	1-2	3-4	5-6	14-20
R 21°C ± 10%	12,4Ω	12,4Ω	2,1Ω	0,5Ω
RMS VOLTAGE	110V	110V	18V	24,5V

Fig. 3.51. Circuit diagram of the complete oscilloscope PM 3234

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
32	150475	OPM 3260 02	DO 0783

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		TS 0607	5
☐ Pre sale repair		R 0063 1	2
☐ Preventive maintenance	0021	9 9 0001	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ ☐☐12 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 32 = Switzerland

②Day Month Year 150475 = 15 April 1975

③Type number/Version OPM3260/02 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number DO0783 = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric,the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve,transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

Argentina: Philips Argentina S.A.,
Casilla de Correo 3479, (Central), 1430 Buenos Aires;
tel. 542-2411/51 and 41-4071/78

Australia: Philips Scientific & Industrial
Equipment Division, Centre Court,
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